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IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

H. STUART CUNNINGHAM
At _____ o'clock
CLERK

BALLY MANUFACTURING CORPORATION,)

Plaintiff,)

v.)

CIVIL ACTION NO. 80 C 5048

D. GOTTLIEB & CO.,)
WILLIAMS ELECTRONICS, INC.,)
ROCKWELL INTERNATIONAL CORPORATION,)
and GAME PLAN, INCORPORATED,)

Defendants.)

MEMORANDUM OF PLAINTIFF IN OPPOSITION TO DEFENDANT
ROCKWELL INTERNATIONAL CORPORATION'S MOTION TO DISMISS

Contents: Exhibits A through D

COP

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS, EASTERN DIVISION

BALLY MANUFACTURING CORPORATION)

Plaintiff,)

vs.)

D. GOTTLIEB & CO., WILLIAMS)
ELECTRONICS, INC., AND ROCKWELL)
INTERNATIONAL CORPORATION,)

Defendants,)

and)

BALLY MANUFACTURING CORPORATION,)

Plaintiff,)

vs.)

GAME PLAN, INCORPORATED, AND)
ASTRO GAMES, INC.,)

Defendants.)

Civil Action
No: 78C 2246

Civil Action
No: 79C 713

DEPOSITION OF JOHN FOOTH

VOLUME VI

December 5, 1979

Reported by:

Shar Starkey-Nordstrom, CSR 2861

AMACK SHORTHAND REPORTING CORPORATION
Certified Shorthand Reporters
1519 East Chapman Avenue
Orange, California 92666
Telephone (714) 538-3806
or (714) 538-2326

1 CONTINUATION OF THE DEPOSITION OF JOHN FOOTH, taken by
2 the Plaintiff, at 3370 East Miraloma Avenue, Anaheim,
3 California, on Wednesday, December 5, 1979, commencing at
4 10:15 a.m., before Shar Starkey-Nordstrom, CSR #2861, a Notary
5 Public, pursuant to subpoena.

6
7
8 APPEARANCES OF COUNSEL:

9 For Plaintiff: BALLY MANUFACTURING CORPORATION

10 FITCH, EVEN, TABIN & LUEDEKA
11 BY: A. SIDNEY KATZ and JEROLD SCHNAYER
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14 For Defendant: ROCKWELL INTERNATIONAL CORPORATION

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16 BY: CLARENCE E. ERIKSEN
17 2100 Transco Tower
18 Houston, Texas 77056

19 E-X-H-I-B-I-T-S

20 PLAINTIFF'S EXHIBIT:

FOR IDENTIFICATION:

21 BD-81 - Subpoena

VI-3

22
23 Series of questions objected to pertaining to Document R-3295-M
24 beginning on Page VI-17, Line 6.

25 Series of questions objected to beginning on Page VI-43,
26 Line 11.

Pages 33 and 86 of Volume VI of the transcript of the deposition of John Footh have been designated by Rockwell as containing confidential information under a protective order entered by this Court in the 2246 case on October 15, 1979, and are therefore submitted to the Court in a separate envelope under seal.

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

COPY

BALLY MANUFACTURING CORPORATION,

Plaintiff,

vs.

D. GOTTLIEB & COMPANY,
WILLIAMS ELECTRONICS, INC.

and

ROCKWELL INTERNATIONAL CORPORATION,

Defendants.

CIVIL ACTION NO. 78 C 2246

and

BALLY MANUFACTURING CORPORATION,

Plaintiff,

vs.

GAME PLAN, INCORPORATED and
ASTRO GAMES, INC.,

Defendants.

CIVIL ACTION NO. 79 C 713

DEPOSITION OF JOHN FOOTH
Volume VII
April 24, 1980

Reported by:

Marvin T. Lusk, CSR #2284

AMACK SHORTHAND REPORTING CORPORATION
Certified Shorthand Reporters
1519 East Chapman Avenue
Orange, California 92666
Telephone (714) 538-3806

1 DEPOSITION OF JOHN FOOTH taken by the Plaintiff
2 at 3370 Miraloma Avenue, Anaheim, California, on Thursday,
3 April 24, 1980, commencing at 10:10 a.m., before Marvin T.
4 Lusk, CSR #2284, a Notary Public, pursuant to Notice.
5
6
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11

12 APPEARANCES OF COUNSEL:

13 For the Plaintiff:

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28

Pages 4 through 7 of Volume VII of the transcript of the deposition of John Footh have been designated by Rockwell as containing confidential information under a protective order entered by this Court in the 2246 case on October 15, 1979, and are therefore submitted to the Court in a separate envelope under seal.

1 A I don't recall.

2 Q Is Rockwell in production at the present time
3 on the Gottlieb System II pinball controllers?

4 MR. ERICKSEN: Don't speculate.

5 THE WITNESS: Yes.

6 Q BY MR. KATZ: Are you aware of the production
7 rate of such System II pinball controllers for Gottlieb?

8 MR. ERICKSEN: I'm going to object to that question.
9 We've routinely excluded quantity and pricing information from
10 discovery. That's been our position throughout.

11 MR. KATZ: I'm not asking. I'm asking if he's aware.
12 Could you read my question back?

13 (Record read.)

14 MR. ERICKSEN: You may answer that question.

15 THE WITNESS: Yes.

16 Q BY MR. KATZ: What is that rate?

17 MR. ERICKSEN: Objection to the question and on
18 relevancy grounds. We've routinely excluded pricing and
19 quantity information, and I'll instruct you not to answer.

20 MR. KATZ: You've excluded it, but we have never agreed
21 to that.

22 MR. ERICKSEN: Mr. Katz, documents you've given me,
23 purportedly Bally documents, have had pricing and pricing
24 information expunged, so don't tell me that you haven't agreed
25 to it. You've done it yourself.

26 MR. KATZ: We're not talking about our information
27 here, we're talking about your information.

28 MR. ERICKSEN: It makes a difference whether it's our

1 information or your information, right?

2 MR. KATZ: Yes.

3 MR. ERICKSEN: I don't think so.

4 MR. KATZ: I'd like to ask the witness for an answer to
5 the question.

6 MR. ERICKSEN: I've instructed you not to answer it.

7 Q BY MR. KATZ: Do you accept your counsel's
8 instruction?

9 A Yes.

10 Q Are you involved in any re-contacts with the
11 Gottlieb people concerning the System II pinball controller?

12 A Yes.

13 Q And what are -- what is the general frequency of
14 those contacts?

15 A It varies.

16 Q From what to what?

17 A Well, it depends. If somebody's got a question,
18 or has a problem, then we have a conversation.

19 Q And what are the typical questions or problems
20 which you have in mind?

21 A Oh, field reports.

22 Q Anything else?

23 A Improvements to the control system.

24 Q Anything else?

25 A Parts procurement.

26 Q Anything else?

27 A I don't recall.

28 Q Do you have any understanding or belief as to

1 why they communicate with you concerning these problems, as
2 opposed to someone else?

3 A No.

4 Q Do you have any idea why?

5 MR. ERICKSEN: I'm going to object to that question on
6 the grounds that it calls for this witness to testify about
7 the thought processes of others, and if you undertake to
8 answer the question, you should state in your answer the
9 basis for such answer.

10 MR. KATZ: That's fine.

11 THE WITNESS: Well, I'm the engineer on this side of
12 the program, and we generally discuss potential problems to
13 the configuration or the production of it. Basically, I'm
14 always consulted by the program manager in these matters.

15 Q BY MR. KATZ: Is that Mr. Gross?

16 A Yes.

17 Q What are the field reports that you mentioned?

18 A Just basic discussions of how the machines are
19 performing out in the field.

20 Q Do they ever report to you anything in respect to
21 competitor's machines from the field?

22 A I don't recall.

23 (Discussion held off record between Mr. Katz and Mr.
24 Schnayer.)

25 Q BY MR. KATZ: Mr. Footh, I ask you to take a look
26 in your notebook, the third book which was -- runs through the
27 period of December 6, '76, through May 31, '77, I believe, and
28 please turn to page 4 in that book.

1 before?

2 A Yes.

3 Q And what do you recognize this to be?

4 A This I.L. is a response to a higher level of
5 corporate, assessing the risk of follow-on business.

6 Q What do you mean by risk of follow-on business?

7 A I don't know the details. It's in that
8 directive.

9 Q I just mean what did you mean by the terms of
10 follow-on business?

11 A Well, I suppose it means whether it's going to be
12 profitable.

13 Q Are you familiar with the -- strike that.

14 This document says, "John Footh, the responsible
15 designer since the beginning of the Gottlieb program remains
16 the full-time responsible engineer through the follow-on
17 program."

18 Did that in fact occur? Did you remain the full-
19 time responsible engineer through the follow-on program?

20 A Yes.

21 Q This document says, "36,000 sets of Gottlieb
22 pinball printed circuit modules have been delivered through
23 July, 1978, at a rate of 5,000 sets per month." It goes to
24 to say, "A set consists of a control board, a master driver
25 board, a four digit display board and four, six digit display
26 boards."

27 Do you know whether that's an accurate statement of
28 fact as of August, 1978?

1 A No.

2 Q Do you have any belief that would be
3 inconsistent with that statement?

4 A No.

5 Q Did this follow-on proposal -- strike that.

6 Does this follow-on program continue beyond the
7 August, 1978, date that this document bears?

8 A Yes.

9 Q For how long?

10 A I don't recall.

11 Q Did it continue into 1979?

12 A I don't recall.

13 Q Do you know if it's still continuing today?

14 A No.

15 Q It's not continuing -- were you the responsible
16 designer throughout the entire follow-on program?

17 A Yes.

18 Q Do you have any idea as to when that program
19 terminated?

20 MR. ERICKSEN: I think the question has been asked and
21 answered. How many times are you going to ask it? The witness
22 has testified he didn't recall.

23 THE WITNESS: I don't recall. Our business is done by
24 contract, and I don't know when the contract begins and ends.

25 Q BY MR. KATZ: I understand you don't recall the
26 specific date when it ends?

27 A That's right.

28 Q But do you have any idea as to when it would have

1 ended or did end?

2 A No.

3 Q Was this follow-on program superceded or
4 succeeded by another follow-on program with respect to the
5 Gottlieb pinball controller?

6 MR. ERICKSEN: Objection to the question as leading.
7 Also vague as to what is meant by the Gottlieb pinball
8 program.

9 THE WITNESS: Do you want me to answer.

10 MR. ERICKSEN: If you can.

11 THE WITNESS: Yes.

12 Q BY MR. KATZ: And how did that program differ
13 from this program

14 MR. ERICKSEN: What program is "that program"?

15 Q BY MR. KATZ: The program, the succeeding
16 program, how did that follow-on program differ from the
17 follow-on program that was the subject of this document,
18 R3530M?

19 A I don't have any way of knowing.

20 Q But it also dealt with Gottlieb pinball
21 controllers?

22 A Yes.

23 Q And is there currently some follow-on program of
24 Rockwell dealing with Gottlieb pinball controllers?

25 A Yes.

26 Q And are you the responsible engineer on that
27 follow-on program, the one that's currently in existence?

28 A Yes.

AMUSEMENT GAME MICROPROCESSOR CONTROLLER

ABSTRACT

A microcomputer based pinball game controller having three distinct memory devices for control of game operation. A first memory device utilizes machine language programming instructions for control of the game independent of specific game rules thus lending itself to mass production for a large number of different amusement games. A second memory device employs a higher level language set of instructions for controlling the game in accordance with the specific rules of the game. A simple set of higher level language instructions renders this second memory device conducive to game designer programming and easy modification of the game rules, a marketing procedure traditionally used in the design of the electromechanical pin ball machine. A third memory device, employing a matrix of operator adjustable binary switches easily accessible to the exterior of the game, permits a degree of game mode control, such as the degree of playing difficulty and the number of games for a given coin denomination.

FIELD OF THE INVENTION

This invention relates generally to a microprocessor controlled pinball game, and more specifically to a game rule memory device in combination with a pinball game controller for simplified and low cost game rule programming.

BACKGROUND OF THE INVENTION

A revolution has been taking place in a design of equipment which until now has been implemented with electromechanical devices. The logic and control functions previously performed by conventional relays, time delay relays, stepping relays, timing motors and the like are now being performed by microcomputer controlled systems. Included in this revolution are the fairly complex electromechanical devices known as pinball games.

Most of us have played electromechanical controlled pinball games, but few of us have appreciated the complexity of design that controls the flashing lights, the score, the sound and the entire pinball system. This degree of control system complexity is very
5 suitable to microprocessor applications. In fact, microprocessor control significantly reduces the amount of material and the cost of complex pinball games at the same time increasing reliability and uptime thereby increasing the potential revenue of the arcade owner.

However there is an important problem inherent in the design,
10 production, and subsequent use by parties having substantially different levels of sophistication in electronics-related systems that have traditionally been purely electromechanical in nature. The current invention substantially overcomes this problem providing in effect three different levels of sophistication in the programming of the
15 parameters of a pinball game. The microprocessor electronics and associated interface usually manufactured by an electronics/microprocessor-oriented company includes the most sophisticated programming and design for overall control of the game. Standard memory devices such as read-only memory and random access memory may, by means of the in-
20 vention described herein, be programmed for a large number of different games, each of which has different rules of operation.

The manufacturer of the pinball game per se, although perhaps less sophisticated in design of electronics having been traditionally associated with purely electromechanical devices, is still the ultimate
25 expert on rules of the game to optimize player interest and revenue derived from the public. Accordingly, the current invention provides means for rule programming at a substantially higher language level by the pinball game manufacturer. The extent of the sophistication of the programming requirements is well below that required for the en
30 masse programming of the ROM and RAM memory devices provided by the

electronics manufacturer, but still provides substantial leeway in allowing the game manufacturer to select a set of rules that suits each particular game.

5 The current invention also provides a set of discrete operator adjustments which comprise a relatively low level of programming sophistication, but which still permit the arcade owner to program certain aspects of the game which may vary as a function of where the pinball game is located. For example, these functions include the price of play, the number of games per coin, and the degree of difficulty of
10 the game, which depends upon the sophistication of the player. Clearly, an arcade location would usually dictate a higher level of difficulty than a bus terminal location where the average level of player sophistication is lower.

15 An important byproduct of the current invention is a substantial reduction in the cost of overall manufacture and maintenance of the pinball game. The electronics manufacturer need not provide special electronics for each variation of game rules supplied by the pinball game manufacturer. As a result, all of the microprocessor electronics may be identical, irrespective of the type of game into which it will
20 be installed. Consequently, the game manufacturer, in addition to paying less for the electronics, also reduces his cost for maintenance of the games by needing fewer spare parts for upkeep because virtually all of the electronics are identical for all of his games irrespective of variations in rules and modes of play.

25

SUMMARY OF THE INVENTION

The present invention is a microprocessor controlled pinball game having means for three levels of control program sophistication including overall game action control in response to mass produced and commonly programmed memory storage devices, a higher level language

game rule memory device which permits relatively simple variations in the electronics to accommodate each set of game rules, and a third level of control in the form of binary switch memory accessible to the ultimate consumer for convenient control of simple mode game parameters.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an isometric drawing of a typical pinball game.

Figure 2 is a block diagram of the microcomputer based pinball controller of the invention.

Figure 3 is a diagrammatic illustration of the instruction formats used in conjunction with the game rule memory device of the invention.

Figure 4 is an illustration used to explain the logical equivalencies of a game rule memory device of the invention.

Figure 5 is an illustration of examples of electromechanical logic.

DESCRIPTION OF A PREFERRED EMBODIMENT

Before proceeding to a description of the microcomputer implemented pinball machine, a brief description of the electromechanical version of the pinball game is provided in conjunction with Figure 1.

Electromechanical pinball games may be divided into three major subsystems: the vertical display 12, play field 14, and the credit subsystems. The vertical display 14 shows the player and ball status and each of the player's scores. The electromechanical design for the display is essentially the same for all pinball games except for the art work which ties the system to the scheme of each particular game.

The playing field contains the contact and lights which define the play of the game and electromechanical assemblies for kicking the ball to provide action in the game.

The credit subsystem, accepts information from the mechanical coin mechanism 16a and 16b and displays credits for playing games based upon the price per play and the coin values accepted. The credit system also accepts inputs from the play field logic to award credits for
5 additional games based on achieving specific goals established by the game designer and settings made by the operator of the game. These game credits are stored in a reversible stepping relay which decrements the credit count as credits are spent to play additional games. The credit information is displayed on the vertical display 14.

10 The basic electromechanical building blocks consist of a number of standard elements which are interconnected to provide a proper score when a play field contact, such as roll over switch 18, closes. The contact closure also provides signals to solenoid-operated chimes or bells to latch relays, control lights, and enable circuit paths through
15 contacts which allow varying scores depending on play field action as well as on bonus scores for extra games. The entire system is synchronized by means of a multiscan contact timing motor so that no race conditions will occur. A race condition occurs when uncertainty in relay operation time causes unpredictable circuit paths to be established
20 because different relays may "win the race" to closure in different situations.

The typical electromechanically controlled pinball game contains about 70 coils, of which 20 to 25 are stepping relays, 35 are logic related, and 10 to 15 are used for mechanical lockouts, ball movement
25 or chime solenoids. In one embodiment of a microcomputer controlled pinball game, all of the above-mentioned coils, except those used for chime solenoids, are replaced by the microcomputer.

The typical electromechanical pinball game is developed and produced over an extended period of time. The game designer usually

spends several months defining the location of the play field contacts, any special play field action items, such as solenoid operated bumpers, the scoring for each contact, and any optional scoring sequences under which the bonus system operated. The game designer strives to develop a game which is interesting, having a considerable amount of action, plays for an acceptable period of time, and which has the capability of awarding the typical player approximately 30 to 35 percent free games. These parameters have been empirically established over the approximately 40 year history of pinball games to insure game interest and coin revenue to the machine owners.

Once the game is shipped, the microcomputer-based game must still have a level of programmability by the game/owner operator to achieve the desired play time, player acceptability, free game characteristics and adjustable price as the electromechanical version. The microcomputer based pinball game must give the game designer the same level of design creativity available to him in the traditional electromechanical version. The game designer must still be able to implement variations in the scoring, in the contact logic, and in the general play of the game. Furthermore, changes in these parameters by the game designer must be possible as a result of the method by which pinball games are usually marketed.

Approximately two months before a pinball game is scheduled to go into production, 200 to 300 units are typically put into the field in a test marketing situation. The machines are placed with knowledgeable distributors who maintain detailed records relating to the action of players, the income gathered from the coin collection box, and other pertinent information relating to the general acceptance of the pinball game. This information is fed to the manufacturer so that the game designer can make minor modifications to the game before putting it into production. By means of the current invention, a microcomputer version of the pinball game

permits fast design development, because of the ease of making the changes of the game rule parameters simply by programming a read-only memory device. As a result, unlike the electromechanical versions, in the computer-based games changes in the play of the game can be implemented even as the machine is being readied for shipment.

Referring now to Figure 2, there is shown therein a simplified block diagram of a game controller of the current invention for use in a microcomputer based pinball game. The controller includes a central processing unit 20, a general purpose keyboard display circuit 22, two memory/input-output devices 24 and 26, and one general purpose input-output device 28. These devices provide all of the control capabilities, a total of 4,000 eight bit words of program memory, 1,000 bits of data memory, and 85 input-output lines. The total system is capable of displaying up to 32 decimal digits for scoring purposes and the like and can switch up to 68 discrete power devices such as lamps and coils.

The general purpose keyboard display circuit device 22 provides internal memory for the 32 binary coded decimal digits, and outputs the information in sequential pairs along with digital identification lines. Sequential binary coded decimal codes are supplied to a pair of binary coded decimal-to-7 segment decoded driver units 30 and 32. This configuration of the controller allows CPU 20 to load the internal memory once and then the general purpose keyboard display circuit 22 provides continuous refresh of the display information until it is commanded to change. The display system and the associated digital displays replace the scoring drums of the electromechanical systems. The scoring drums are basically stepping relays typically with several sets of contacts, with a drum around the outer periphery which rotates and shows a different digit for each position of the stepping relay.

The central processor 20 employs a TV crystal base clock oscillator (not shown) and 12 input-output lines. The input-output lines are

used to address the game rule memory device 34. RAM/ROM devices 24 and 26 each have 2,048 eight bits of read-only memory which contains the main controller program. They each also have 128 four-bit words of random access memory for the player scores, status bit memory, play field contact memory and other alterable memory. These devices also have 16 input-output lines each.

The general purpose input-output circuit 22 has a total of 24 input-output lines. The general purpose keyboard display circuit is used to buffer, refresh and control the 32 decimal digits of display. The digit strobe signals are multiplexed in two banks of eight digits. The CMOS random access memory 36 is a device which keeps data available even when power is lost or turned off, and is powered by a battery system 38 to keep the memory active. The operator adjustable matrix 40 is an array of diodes which may be independently switched in or out of the circuit so that operator selection of preprogrammed game options may be made. Operator adjustable matrix 40 shares strobe lines with 8 of the 5 amp coil drivers. These coil drivers may be shared because the matrix information may be read in a few microseconds which is too short for the solenoids or relay armatures to react. The 8x8 contact matrix 42 is scanned by signals from one of the RAM/ROM devices and return signals are read into the general internal memory to prevent bouncing error and appropriate action is initialized. Because up to 16 coil drives and up to 52 lamp drives are required in a pinball game, the output signals from the 15 four bit latches 44 go to two types of drivers: 5 amps and 250 milliamps respectively.

The play field system, which is visible to the eye of the player, is virtually unchanged in the microcomputer version of the pinball game. The mechanical devices which propel the ball are still necessary for exciting field action. Scoring contacts are closed to provide signals to the microcomputer rather than to operate conventional relays and stepping

relays found in the electromechanical games. Indicator lights showing the play field scoring status are implemented in the microcomputer game by drivers which receive a control signal from conventional TTL latches. The microcomputer selects the information to be sent to the latch and
5 outputs it while at the same time identifying which latch is to receive the information. The contact closure information is obtained in the microcomputer system by providing a sequence of scanning signals which selects sequential groups of contacts. The microcomputer inputs the information from each group and performs the debounce function.

10 Because of implementation with a microcomputer, the pinball game can be provided with a capability which is not achievable in the electromechanical version. The microcomputer can be put into a special mode when the coin collector comes to collect the coins. This mode tests the overall operation and identifies by means of the display system,
15 the contact identification information for every contact which is stuck. During this test mode the microcomputer can also output various display patterns to check the display system. It can also drive the lights to check operation of all the light bulbs and can individually drive all the solenoids of the play field and coin system to check their operation.
20 In addition, the microcomputer can provide various bookkeeping and status information to the coin collector not possible with the electromechanical system. In the microcomputer system the bookkeeping information is stored in low power dissipation CMOS memory 36 which maintains its information even when system power is off, by means of small battery system 38.

25 The central processing unit 20 of Figure 2, may by way of example be a Rockwell model PPS 4/2 CPU which is described in more detail in data sheet Document No. 29C00D02 published by Rockwell International Corporation in 1975 and Revised March 1976.

30 The ROM/RAM devices 24 and 26 of Figure 2 may by way of example be a Rockwell model A17XX described in more detail in data sheet Document

No. 29000028 published by Rockwell International Corporation in 1975 and Revised in October 1976.

5 The GP10 (General Purpose Input/Output Device) 28 of Figure 2 may by way of example be a Rockwell Model GP10 chip described in more detail in data sheet Document No. 29000006 published by Rockwell International in 1975.

10 The GPKD (General Purpose Keyboard and Display Circuit) 22 of Figure 2 may by way of example be a Rockwell GPKD circuit chip described in more detail in data sheet Document No. 10788N40 published by Rockwell International in 1975.

The PROM utilized for storing the higher level language program may by way of example be a programmable read only memory Model 6351 manufactured by Monolithic Memories Incorporated.

15 The requirement for stepping relays for bonus advancing or for timing motors to eliminate race conditions is eliminated from the microcomputer system. The position of a stepping relay can be implemented in the microcomputer by storing a number in memory representing the stepper position. The microcomputer can use this number as part of a program logic sequence to implement the desired function for that position. The
20 microcomputer can provide sequence information much more readily and because of the sequential operation of the microcomputer, the timing motor is not required since race conditions are impossible.

The software approach used in the implementation of the microcomputer pinball game of the current invention is actually implemented
25 in three levels: the first programming level includes those basic control functions that every pinball game controller is expected to perform. These are the necessary power on, sequencing and control, display operation, player and ball counting operations, play field input computations, general play field control operations for functions such as "tilt" and functions
30 which occur when the ball leaves the playing field, and similar operations

which do not change from game to game. This program is generated by the controller designer to allow the system to be a general pinball game controller, and is the program stored in the microcomputer fixed read-only memory contained in the RAM/ROM devices 24 and 26.

5 The next level of programming is generated by the game designer and is accomplished in an interpretative program format. This means that the game controller program in the RAM/ROM devices interprets programs written in a higher level language oriented toward pinball game rules. Using this higher level language, the game designer selects
10 the operation response to each contact in easy to use sentence descriptions of the rules of the game. The instructions used in this higher level pinball-game oriented language (PGOL) are indicated in Table I and the instruction format for two types of instructions are presented in Figure 3.

 As indicated in Figure 3 there are basically two types of instruction format. Format A is used for copying or setting the logic state
15 on certain lights, flags, or solenoids as the game proceeds. Instruction format B is used to control the score of the game. As indicated in Figure 3, each instruction format includes an OP code comprising four bits. This OP code identifies the instruction generated. The Format A instruction also
20 includes a true-false bit which indicates whether the flag, light, or solenoid, the state of which is being copied or set, should be copied or set in its current state or in an inverted state. A light-flag bit indicates whether the instruction will have an effect on a light or on a flag or solenoid. The right-most eight bits of the Format A instruction include
25 a light or flag address word of six bits and a light or flag subaddress comprising two bits. In combination these eight bits designate the specific light, flag or solenoid the instruction operates on.

 The Format B instruction, which is specifically oriented to effecting scoring changes, includes an add-subtract bit which indicates whether
30 an addition or subtraction should be made to a score. It also includes a

TABLE I

PGOL INSTRUCTION SET

<u>INSTRUCTION</u>	<u>OP CODE</u>	<u>ADDRESS</u>	<u>FUNCTION</u>
*COPY	0	TLBB CCCC	COPY LAMP/FLAG STATE TO CONTROL BIT
*SCORE	1	ANNN VVVV	ADD/SUBTRACT TO/FROM SCORE
*SET	2	TLBB CCCC	SET/RESET LAMP/FLAG/SOL
*CGOTO	3	QQQQ RRRR	CONDITIONAL GO TO LOCATION/QQQQ RRRR
RFLG	4	- -	ROTATE FLAGS (11-20) LEFT ONE POSITION
*RBUP	5	- -	BONUS UP
*RBDN	6	- -	BONUS DOWN
*REQL	7	MMMM -	IF REG \neq MMMM, CONTROL BIT = 0.
*DECR	8	- -	DECREMENT INDEX REGISTER
*INCR	9	- -	INCREMENT INDEX REGISTER
OR	A	TLBB CCCC	OR LAMP/FLAG STATE WITH CONTROL BIT
FLAG	B	- -	SET CONTROL BIT = 1
STOP	C	- -	RETURN TO MAIN PROGRAM
TOGL	D	- -	TOGGLE CONTROL BIT
GOTO	F	QQQQ RRRR	GO TO LOCATION QQQQ RRRR
DELAY	F	- -	150 MILLISECONDS DELAY

*ONLY EXECUTED IF THE CONTROL BIT = 1

column number comprising three bits which indicate which column of the score display is being affected by the current instruction. Finally, the instruction contains four bits indicating the number of operations to effect the score change. For example, if 5,000 is to be added to the score, the add bit would be TRUE, the column number would correspond to five, so that one would be added five times to the thousands column of the score.

When a contact on the play field closes in response to the play of the game, the controller program stored in the RAM/ROM devices causes the instructions in a particular section of the higher level language memory to be executed. The sequence of instructions starting at a particular program location corresponding to the contact closure, indicates exactly what the game is to do when the contact closes. For example, one contact may simply cause the system to score 100 points for the player who is operating the game. In this case, the higher level language program consists of two instructions: 1) score 100 points and 2) stop. The stop code indicates the completion of the operation related to this particular contact closure. If another contact is closed, the controller may cause the instruction sequence for that contact to be executed; for example, the contact instructions may be as follows: when contact 1 closes, if contact 3 and contact 11 have been closed, score 1,000, otherwise score 100 and stop. This requires six higher level language instructions to implement. In both of these examples, the controller program interprets what the game designer defined by the higher level language instructions and executes a sequence of machine language instructions to accomplish each instruction and to continue to the next one.

The philosophy of operation of the higher level language program is that a controlled flag bit in a microcomputer memory is initially set to a ONE state. A higher level language instruction inspects the state

of that bit and performs the operation specified if the bit continues to be in the ONE state. Many of the logic type higher level language instructions control the state of the bit to cause blocks of logic to be ignored or executed as the situation demands. The unconditional instructions control the flow of the logic and always execute regardless of the state of the control bit or flag bit. The higher level language is a general logic language with some special instructions which relate to pinball operations. Special pinball instructions are the "score" instructions, the "increment-decrement bonus" instructions, the "increment-decrement" register instruction and the "register equal" instructions.

From the instructions listed in Table 1, it can be seen that the full capability for sequential logic is provided by AND functions and OR functions with TRUE or FALSE states. Figure 4 illustrates the equivalent high level language statement for the four basic logic operations. These four basic logic operations are shown in relay circuit, logic gate symbols, and higher level language statement forms. In the logic gate illustrations, the input lines on the left are active when the line is shaded. If the gate passes a signal, the output is shaded. The shaded inputs are then equivalent to the relay being activated in the relay logic, or to the bit memory being in the ON state in the higher level language equivalent.

The higher level language program provides a capability for counting events and making decisions based upon the actual value of the count. Also provided is the capability for inserting time delays and for setting, resetting, and testing individual status bits in a bit memory in the microprocessor system to store the status of contact closures, light bulb drives, coil drives and logic information.

Using the higher level language program, the game designer can easily and quickly configure the logical options for a particular game and modify them as he develops information about the general play of the game and its level of difficulty. In one embodiment of the invention,

this higher level language program is implemented in programmable read-only memory PROM, even in the production system, so that the game modifications which must be made from feedback from the field operations can be implemented right up to the last moment in the production line.

5 A general example for implementing a block of mechanical logic with the higher level language programming of the current invention is illustrated in Figure 5. The higher level language program statements corresponding to the electromechanical logic of Figure 5 would be as indicated below:

10 If register equals 5, set bit D, always.
If register equals 4, set bit E, always.
If register equals 3, and if bit C is on, set bit F, always.
If register equals 2, and if bit A is off, and if bit B is
on, and if bit C is off, set bit G always.
15 Or if register equals 2, and if bit A is on, and bit B is
off, and bit C is off, set bit G always.
If register equals 1, and if bit A is off and if bit B
is on and if bit C is on, set bit H always.
If register equals 0, and if bit A is on, set bit K.
20 STOP

Table 11 is a program listing of a programmable read only memory unit used in a preferred embodiment of the invention to store the higher level language used for game rule control. The column on the left is the input address to the PROM, expressed in hexadecimal format. The next
25 four columns, labeled W1, W2, W3 and W4 respectively, are the hexadecimal representations of the output of the PROM generated in response to the input address. The next column to the right is an instruction number used for reference in the listing. The next column to the right is a label used to identify each step in the listing for GoTo operations. The next
30 column to the right is the name of the OP code for each instruction in

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ADDR W1 W2 W3 W4

TABLE II

ISN.	LABEL	OP	OPERAND
1			PGOL PROGRAM LISTING - GAME #409
2	FLAGS		F11-F20 KICKOUT HOLE-SPOT ROLLOVER INDICATORS
3			F1 ALL ROLLOVERS DOWN
4			F2 ALL DROP TARGETS DOWN
5			F3 ALL DROP TARGETS DOWN 1ST PASS ONLY
6			F4 SPECIAL AWAKO
7			L4 SAME PLAYER SHOOT AGAIN
8			F5 SPECIAL HIT
9			F6 EXTRA BALL HIT
10			F18 SPALL=0 SPALL=1
11			F7 TEMP FLAG -(10 POINTS)
12			F9 TEMP FLAG
13			F21 EXTRA BALL
14			
15		GOTO	INIT
16		GOTO	BONUS
17		FILL	24
18	S10P	GOTO	10P
19	SCP8	GOTO	CP8
20	SR1G	GOTO	RTG
21	SC1G	GOTO	CTG
22	SL1G	GOTO	LTG
23		FILL	12
24	SR20	GOTO	BR01
25	SR00	GOTO	GR01
26	SR08	SCORE	A1000.5
27		ST00	
28	SW0T	GOTO	W0T
29	SY0T	GOTO	Y0T
30		FILL	12
31	SC0T	GOTO	G0T
32	SW00	GOTO	RW01
33	SD0T	GOTO	RT
34	SY00	GOTO	YR01
35	SR00	GOTO	WR01
36		FILL	12
37	SR0R	GOTO	POP
38	SR0L	GOTO	RPL
39	SL0L	GOTO	LML
40	SD0T	GOTO	H0T
41			
42			YELLOW ROLLOVER
			10 POINT
			CENTER POP BUMPER
			RIGHT TARGET
			CENTER TARGET
			LEFT TARGET
			BLUE ROLLOVER
			GREEN ROLLOVER
			RIGHT ROLLOVER BUTTON
			WHITE DROP TARGET
			YELLOW DROP TARGET
			GREEN DROP TARGET
			RED ROLLOVER
			RED DROP TARGET
			YELLOW ROLLOVER
			WHITE ROLLOVER
			RIGHT POP BUMPERS
			RIGHT HOLE
			LEFT HOLE
			BLUE DROP TARGET

TABLE II (CONTINUED)

PSA 04/10/74	ADD2 W1 W2 W3 W4	ISN	LABEL	OP	OPERAND
0120 0 C 7	43	YPO1	COPY	TL28	
0123 2 4 7	44		SET	FL28	
0124 2 6 6	45		SET	FL22	
0129 2 C 2	46		SET	TL3	
012C 0 0	47		INCR	ROV	
012D 0 1 D E	48		GOTO	ROV	
	49				
	50				
	51				
	52				
01A1 0 D 8	53	WR01	COPY	TL29	
01A4 2 5 8	54		SET	FL29	
01A7 2 7 6	55		SET	FL23	
01AA 2 E 2	56		SET	TL6	
01AD 0 1 D E	57		INCR	ROV	
01AE 0 1 D E	58		GOTO	ROV	
	59				
	60				
01P2 0 E 8	61	RR01	COPY	TL30	
01P5 2 6 8	62		SET	FL30	
01P8 2 D 2	63		SET	TL5	
01P2 0 1 D E	64		INCR	ROV	
01PC 0 1 D E	65		GOTO	ROV	
	66				
	67				
	68				
01C0 0 F 8	69	BR01	COPY	TL31	
01C3 2 7 8	70		SET	FL31	
01C6 2 4 6	71		SET	FL24	
01C9 2 F 2	72		SET	TL7	
01CC 0 1 D E	73		INCR	ROV	
01CD 0 1 D E	74		GOTO	ROV	
	75				
	76				
	77				
	78				
01D1 0 C 8	79	GR01	COPY	TL32	
01D4 2 4 8	80		SET	FL32	
01D7 2 5 7	81		SET	FL25	
01DA 2 D 3	82		SET	TL9	
01DD 0 1 D E	83		INCR	ROV	
	84				
	85				
	86				
	87				
	88				
	89				
	90				
	91				
	92				
	93				
	94				

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TABLE II (CONTINUED)

PBA 06/10/76	ADDP W1 W2 W3 W4	ISN	LABEL	OP	OPERAND
0230	C E 3	127	DT	COPY	TL10
0233	O F 3	128		COPY	TL11
0236	O C 3	129		COPY	TL12
0239	C D 4	130		COPY	TL13
023C	O E 4	131		COPY	TL14
023F	2 A 0	132		SET	TF2
0242	2 B 0	133		SET	TF3
0245	2 C 7	134		SET	TL26
		135			CENTER TARGET
		136			
		137			
		138			
0248	B 1	139		FLAG	
0249	7 1	140		REPL	1
024A	1 A 1	141		SCORE	A1000,1
024E	H 2	142		FLAG	
024F	7 2	143		REPL	2
0251	1 A 2	144		SCORE	A1000,2
0254	H 3	145		FLAG	
0255	7 3	146		REPL	3
0257	1 A 3	147		SCORE	A1000,3
025A	H 4	148		FLAG	
025B	7 4	149		REPL	4
025D	1 A 4	150		SCORE	A1000,4
0260	H 5	151		FLAG	
0261	7 5	152		REPL	5
0263	1 A 5	153		SCORE	A1000,5
0266	H 3 D 2	154		FLAG	
0267	E 3 D 2	155		GOTO	RONT
		156			
		157			
		158			
		159			
		160			
0269	2 F 5	161		SET	TL19
026E	O D 3	162		COPY	TL9
0271	O E 4	163		COPY	TL14
0274	1 A 1	164		SCORE	A1000,1
0277	F F 5	165		FILL	2
0279	O C 5	166		COPY	TL20
027C	O D 6	167		COPY	TL21
027F	1 A 1	168		SCORE	A1000,1
0280	F F 1	169		FILL	2

TABLE II (CONTINUED)

PBA 06/10/76	ADDP W1 W2 W3 W4	ISN	LABEL	OP	OPERAND
02R4 B	2 7 5	169		FLAG	FL19
02R5		170		SET	
		171		YELLOW BONUS	
		172			
		173		YELLOW	
02R6	2 E 5	174		SET	TL18
02R7	0 C 2	175		COPY	TL8
02R8	0 D 4	176		COPY	TL13
02R9	1 A 2	177		SCORE	A1000.2
02R0	1 F 1	178		FILL	2
02R1	0 C 5	179		COPY	TL20
02R2	0 D 6	180		COPY	TL21
02R3	1 A 2	181		SCORE	A1000.2
02R4	1 F 1	182		FILL	2
02R5	0 C 5	183		FLAG	
02R6	1 B 2	184		SFT	FL18
02R7	2 6 5	185		BLUE BONUS	
02R8	2 D 5	186		SET	TL17
02R9	0 F 2	187		COPY	TL7
02R0	0 C 3	188		COPY	TL12
02R1	1 A 3	189		SCORE	A1000.3
02R2	1 F 1	190		FILL	2
02R3	0 C 5	191		COPY	TL20
02R4	0 D 6	192		COPY	TL21
02R5	1 A 3	193		SCORE	A1000.3
02R6	1 F 1	194		FILL	2
02R7	0 C 5	195		FLAG	
02R8	1 B 2	196		SFT	FL17
02R9	2 5 5	197		WHITE BONUS	
02R0	2 C 4	198		SET	TL16
02R1	0 E 2	199		COPY	TL6
02R2	0 F 3	200		COPY	TL11
02R3	1 A 4	201		SCORE	A1000.4
02R4	1 F 1	202		FILL	2
02R5	0 C 5	203		COPY	TL20
02R6	0 D 6	204		COPY	TL21
02R7	1 A 4	205		SCORE	A1000.4
02R8	1 F 1	206		FILL	2
02R9	0 C 5	207		FLAG	
02R0	1 B 2	208		SFT	FL16
02R1	2 4 4	209			
02R2		210			

TABLE II (CONTINUED)

PRA 06/10/76.	ADDR X1 W2 X3 W4	ISN	LABEL	OP	OPFRAND
02DF	2 F 4	211	* RED BONUS		
02E2	0 D 2	212	SET	TL15	
02F5	0 E 3	213	COPY	TL5	
02EA	1 A 5	214	COPY	TL10	
02EB	F F 5	215	SCORE	A1000.5	
02ED	0 C 5	216	FILL	2	
02FO	0 U 6	217	COPY	TL20	
02FJ	1 A 5	218	COPY	TL21	
02FA	F F	219	SCORE	A1000.5	
02FH	B B	220	FILL	2	
02F9	2 7 4	221	FLAG	FL15	
02FC	C C	222	SET		
		223	STOP		
		224			
		225	* CENTER TARGET		
02FD	0 6 7	226	CTG	COPY FL26	CENTER TARGET=1 ?
0300	1 B 5	227		SCORE A100.5	
0303	D A 5	228		TUGL	
0304	1 A 5	229		SCORE A1000.5	
0307	C C	230		STOP	
		231			
		232			
		233	* LEFT HOLE		
		234			
0308	2 C 5	235	LHL	SET TL20	LEFT HALF DOUBLE BONUS=1
030B	2 2 5	236		SET FF22	
030E	E 3 1 8	237		GOTO HOLE	
		238			
		239			
		240	* RIGHT HOLE		
0312	2 D 6	241	RHL	SET TL21	RIGHT HALF DOUBLE BONUS=1
0315	2 A 5	242		SET TF22	
0318	0 A 9	243	HOLE	COPY TF38	3 BALL ?
031N	1 A 5	244		SCORE A1000.5	SCORE 5000
031E	U A 3	245		TUGL	OTHERWISE
031F	1 A 3	246		SCORE A1000.3	SCORE 3000
0322	B B	247		FLAG	
0323	0 A 5	248		COPY TF22	
0324	2 A D	249		SET IS6	
0329	U D	250		TUGL	
032A	2 B D	251		SET	
		252		SET	

TABLE II (CONTINUED)

PSA 04/10/76	ADDR W1	W2	W3	W4	ISN	LABEL	OP	OPERAND
0320	B	2	A	8	253		FLAG	TF34
032E	2	A	R	1	254		SET	TF8
0331	2	R	1	2	255		SET	TF12
033A	0	R	2	2	256		COPY	TF38
0337	0	A	9	9	257		COPY	TF11
033A	A	B	2	2	258		OR	YR01
0330	E	1	9	0	259		GOTO	
0341	H	3	3	3	260		FLAG	TF14
0342	0	A	9	9	261		COPY	TF38
0345	0	A	9	9	262		COPY	TF13
0348	A	2	3	3	263		OR	WR01
0348	E	1	A	1	264		GOTO	
034F	R	3	3	3	265		FLAG	TF16
0350	0	B	3	3	266		COPY	TF38
0353	0	A	9	9	267		COPY	TF15
0354	A	B	3	3	268		OR	RR01
0359	E	1	B	2	269		GOTO	
0350	B	4	4	4	270		FLAG	TF18
035E	0	A	9	9	271		COPY	TF38
0341	0	A	9	9	272		COPY	TF17
0344	A	9	4	4	273		OR	RR01
0367	F	1	C	0	274		GOTO	
0368	B	8	4	4	275		FLAG	TF20
026C	0	8	4	4	276		COPY	TF38
036F	0	A	9	9	277		COPY	TF19
0372	A	B	4	4	278		OR	GP01
0375	E	1	D	1	279		GOTO	
0379	B	2	0	1	280		FLAG	TF8
037A	2	0	1	1	281		SET	
0370	C	2	0	1	282		STOP	
					283			
					284			
					285			
037E	1	B	1	1	286		LEFT OR RIGHT POP BUMPERS	
0381	4				287			
					288			
					289			
					290			
0382	E	4	5	9	291			
					292			
					293			
					294			
					295			
					296			
					297			
					298			
					299			
					300			
					301			
					302			
					303			
					304			

TABLE II (CONTINUED)

PBA 06/10/76	ADDR W1	W2	W3	W4	ISN	LABEL	OP	OPERAND	
0306	1	B	5		295	LTG	SCORE A100+5	SPECIAL ?	
0309	0	F	9		296		COPY TL35	L35=0	
030C	2	7	9		297		SET FL35	DISAPLE SPECIAL	
030F	2	9	1		298		SET TF5	CREDIT FLAG	
0312	2	8	0		299		SET TF4		
0315	2	8	0		300		FLAG	EXTRA BALL=1 ?	
0318	0	E	9		301		COPY TL34	L34=0	
031B	2	6	9		302		SET FL34	DISAPLE EXTRA BALL	
031E	2	A	1		303		SET TF6	EXTRA BALL FLAG	
0321	2	9	5		304		SET TF21		
0324	2	C			305		STOP		
0327	0				306				
032A	0				307		RIGHT TARGET		
032D	0				308				
0330	1	B	5		309	RTG	SCORE A100+5	SPECIAL ?	
0333	0	C	9		310		COPY TL36	L36=0	
0336	2	9	1		311		SET FL36		
0339	2	9	1		312		SET TF5	CREDIT FLAG	
033C	2	8	0		313		SET TF4		
033F	0	D	9		314		FLAG	EXTRA BALL ?	
0342	0	D	9		315		COPY TL33	L40=0	
0345	2	5	9		316		SET FL33		
0348	2	A	1		317		SET TF6	EXTRA BALL FLAG	
034B	2	9	5		318		SET TF21		
034E	2	C			319		STOP		
0350	0				320				
0353	0				321		CENTER POP BUMPER		
0356	0				322				
0359	0	A	9		323	CPR	COPY TF30	3 BALL ?	
035C	1	A	1		324		SCORE A100+1	SCORE 1000	
035F	0	H	1		325		TOGL	OTHERWISE	
0362	1				326		SCORE A100+1	SCORE 100	
0365	0				327		STOP		
0368	0				328				
036B	0				329		10 POINTS		
036E	0				330				
0370	1	C	1		331	JOP	SCORE A10+1	ALTERNATE SPECIAL AND EXTRA BALL LIGHT:	
0373	2	A	8		332		SET TF36		
0376	0				333		STOP		
0379	0				334				
037C	0				335		ROLLOVER AND DROP TARGET EXIT ROUTINE		
037F	0				336	ROPT	COPY TF3	1ST PASS ?	

TABLE II (CONTINUED)

PSA 06/10/75	AUDR W1 W2 W3 W4	ISN	LABEL	OP	OPRAND	
0305	0 6 9	337		COPY	FL34	(L33.L34)=0 ?
0308	0 5 9	338		COPY	FL33	EXTRA HALL NOT HIT ?
0309	0 2 1	339		COPY	FF6	
030E	0 7 9	340		COPY	FL35	
0311	0 4 1	341		COPY	FL4	
0314	0 4 1	342		SET	TL34	
0317	2 E 9	343		FLAG		
031H	0 R 0	344		COPY	IF3	1ST PASS ?
031R	0 9 0	345		COPY	TF1	ALL POLLOVERS ?
031F	0 A 0	346		COPY	IF2	ALL DROP TARGETS ?
03F1	0 6 9	347		COPY	FL34	L34=0 ?
03F4	0 1 1	348		COPY	FF5	
0317	2 F 9	349		SET	TL35	L35=1 (SPECIAL)
03FA	0 B 0	350		FLAG		
03FH	0 B 0	351		COPY	IF3	1ST PASS ?
031E	0 9 0	352		COPY	TF1	ALL POLLOVERS ?
0401	0 A 0	353		COPY	TF2	ALL DROP TARGETS ?
0404	0 5 9	354		COPY	FL33	L33=0 ?
0407	0 7 9	355		COPY	FL35	
040A	0 1 1	356		COPY	FF5	
040D	2 C 9	357		SET	TL34	L36=1 (SPECIAL)
0410	0 B 0	358		FLAG		
0411	2 3 0	359		SET	FF3	
0414	0 C 0	360		STOP		
* * * INITIALIZATION						
0415	2 C 7	361	INIT	SET	TL28	
0419	2 D 8	362		SET	TL29	
041B	2 E 8	363		SET	TL30	
041E	2 F 8	364		SET	TL31	
0421	2 C 8	367		SET	TL32	
0424	2 E 6	368		SET	TL22	
0427	2 F 6	369		SET	TL23	
042A	2 C 6	370		SET	TL24	
042D	2 D 7	371		SET	TL25	
0430	2 B 7	372		SET	TF11	
0433	2 C 0	373		SET	TF8	
0436	2 B 0	374		SET	TF9	
0439	2 A 0	375		SET	TF9	
043C	0 2 6	376		SET	TF8	
043F	0 9 6	377		COPY	TF27	
043F	0 9 6	378		COPY	TF25	LAST HALL ?

TABLE II (CONTINUED)

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ADDR W1	W2	W3	W4	ISN	LABEL	OP	OPRAND	
0442	2	C	5	379		SLT	TL20	
0445	2	D	6	380		SET	TL21	DOUBLE BONUS=1
0448	8			381		FLAG		
0449	0	A	6	382		COPY	TF26	
044C	0	9	6	383		COPY	TF25	LAST BALL ?
044F	0	A	9	384		COPY	TF34	3 BALL ?
0452	2	C	5	385		SFT	TL20	
0455	2	D	6	386		SFT	TL21	DOUBLE BONUS=1
0458	C			387		STOP		
0459	0	9	0	388				
045C	A	A	0	389				
045F	E	A	6	390	POP01	COPY	TF1	ALL R.O.'S
0463	C			391		OR	TF2	OR CT.HS
0464	0	2	1	392		GOTO	POP1	
0467	E	4	6	393		STOP		
0469	C			394	POP1	COPY	FF6	EXTRA BALL HIT ?
046C	0	2	9	395		GOTO	POP2	NO
046F	E	4	7	396		STOP		YES
0473	C			397	POP2	COPY	FF38	3 BALL ?
0474	0	D	9	398		GOTO	POP3	NO
0477	E	A	2	399		STOP		
0479	B			400	POP3	COPY	TL33	L33=1?
047C	0	E	9	401		GOTO	POP4	YES
047F	E	4	A	402		FLAG		
0483	B			403		COPY	TL34	L34=1 ?
0484	0	C	9	404		GOTO	POP5	YES
0487	E	4	B	405		FLAG		
0489	H			406		COPY	TL36	L36=1 ?
048C	0	F	9	407		GOTO	POP6	
048F	E	4	H	408		FLAG		
0493	H			409		COPY	TL35	L35=1 ?
0494	0	D	5	410		GOTO	POP7	
0497	E	4	B	411		FLAG		
0499	0	3	5	412		COPY	TF23	
049C	2	D	9	413		SET	TL33	
049F	E	4	B	414		FLAG		
04A3	0	3	5	415		COPY	FF23	
04A6	2	E	9	416		SET	TL34	
04A9	C			417		STOP		
04AB	2	S	9	418	POP4	SFT	FL33	L33=0
04AD	2	H	5	419		SFT	TF23	FP3=1
04AE	2	H	5	420				

TABLE II (CONTINUED)

PWA 06/10/76				ISN	LABEL	OP	OPERAND	
ADDR	W1	W2	W3	W4				
04A8	C					STOP		
04A9	2	6	9	421	POPS	SET	FL34	L34=0
04AC	2	3	5	422		SET	FF23	FF23=0
04AF	C			423		STOP		
04B0	2	E	9	424	POF6	SET	TL34	L34=1
04B3	C			425		STOP		
04B6	2	D	9	426	POF7	SET	TL33	
04B7	C			427		STOP		
				428				
				429				

0

the listing. The next column to the right is a name given to the OPERAND of the instruction indicating what the instruction will act on. The final column to the right is a brief explanation of the instruction in the listing.

5 By way of an example in using the program listing of Table II, instruction number 50 is labeled White Rollover. This label corresponds to a series of higher level language instructions which occurs in response to a contact closure when a Rollover switch, such as switch 18 of Figure 1, is activated by the pinball. As indicated at instruction
10 number 52, the input address to the higher level language PROM is 01A1 in hexadecimal form and the output is 0D8 in hexadecimal form. The label given to this instruction and to the five instructions that follow and that together comprise this subroutine designated White Rollover is WR01. The first step is a copy instruction which calls for copying
15 TRUE light 29. The next step, with input address 01A4, output 258, is a set instruction to set FALSE light 29. After two more set instructions, the subroutine calls for an increment of an index register in the PROM by means of input address 01AD and output 9. The final instruction in
20 this subroutine White Rollover, is a GoTo instruction where the address of the destination of the GoTo instruction is ROV which as shown as instruction number 86 is the name of another subroutine called Rollover.

 An example of a Score instruction is shown at instruction number 26 of Table II. The input address of the PROM is 0148, and the output
25 is 1A5 which as indicated by the OPCODE and OPERAND, is an instruction which causes an increase in the score by 5,000 which is accomplished by adding to the 1,000th column a total of five times.

SUMMARY

It will now be understood that what is described herein is a microcomputer based pinball machine controller having a means for three different levels of programming and control. The first level is a machine language program that may be provided in mass production quantities by the controller designer and is capable of accomodating all of the anticipated variations for which the controller may be used irrespective of the particular rules of a pinball game. The second level is a higher level language interpretive routine having a high level language flexible instruction set permitting pinball game designers to utilize their creativity in the design of the rules of the game without requiring large amounts of programming time ordinarily needed to establish the rules of a particular game. The third level, the least sophisticated in terms of an actual knowledge of the detailed electronics of the controller, permits operator control by means of binary switches of general game mode operations, such as the difficulty of play and the number of plays for each coin.

Although a specific embodiment has been described it will be understood that the invention is not limited to the particular implementation utilized and that the invention could be implemented in other forms of logic including other types of hardware and software to accomplish the operations described herein. However, all such alternative embodiments are contemplated within the scope of the invention.

The invention has been described in more than sufficient detail to enable one skilled in the art to make and use the invention. For purposes of brevity and to avoid inadvertent obfuscation of the important elements of the invention, certain trivial aspects have not been described in specific detail. By way of example, specific time relationships of clock signals have not been specifically delineated. However, these

aspects of the invention will now be readily apparent to those having skill in the applicable art and having the teaching of the applicants before them.

5 The invention described herein may be employed in many ways different from that specifically set forth and many variations may be made therein within the scope of the appended claims.

1 claim:

1 1. In a microprocessor control amusement game having lamps,
2 coils, and display, a game controller comprising:
3 a central processing unit,
4 a contact matrix providing input signals to said processing
5 unit in response to player operated game operation,
6 a machine language memory device connected to said central
7 processing unit for storing pre-programmed instructions for control of
8 game operation independent of the specific rules of the game,
9 a game rule memory device connected to a central processing
10 unit for storing program instructions for control of game operation dependent
11 upon the specific rules of the game,
12 output signal driver means connected to said central processing
13 unit for applying signals to said lamps, coils, and display in response to
14 said input signals, said machine language memory device instructions, and
15 said game rules memory device instructions.

1 2. A game controller as defined in Claim 1, further
2 comprising:
3 an operator adjustable matrix memory device connected
4 to said machine memory device and programmed for mode control of
5 said game.

1 3. A microprocessor amusement game controller comprising:
2 first programmed means for controlling game operation
3 independent of the specific rules of play,
4 second program means for controlling game operation
5 dependent upon the specific rules of play, and
6 third program means for controlling the mode of game
7 operations.

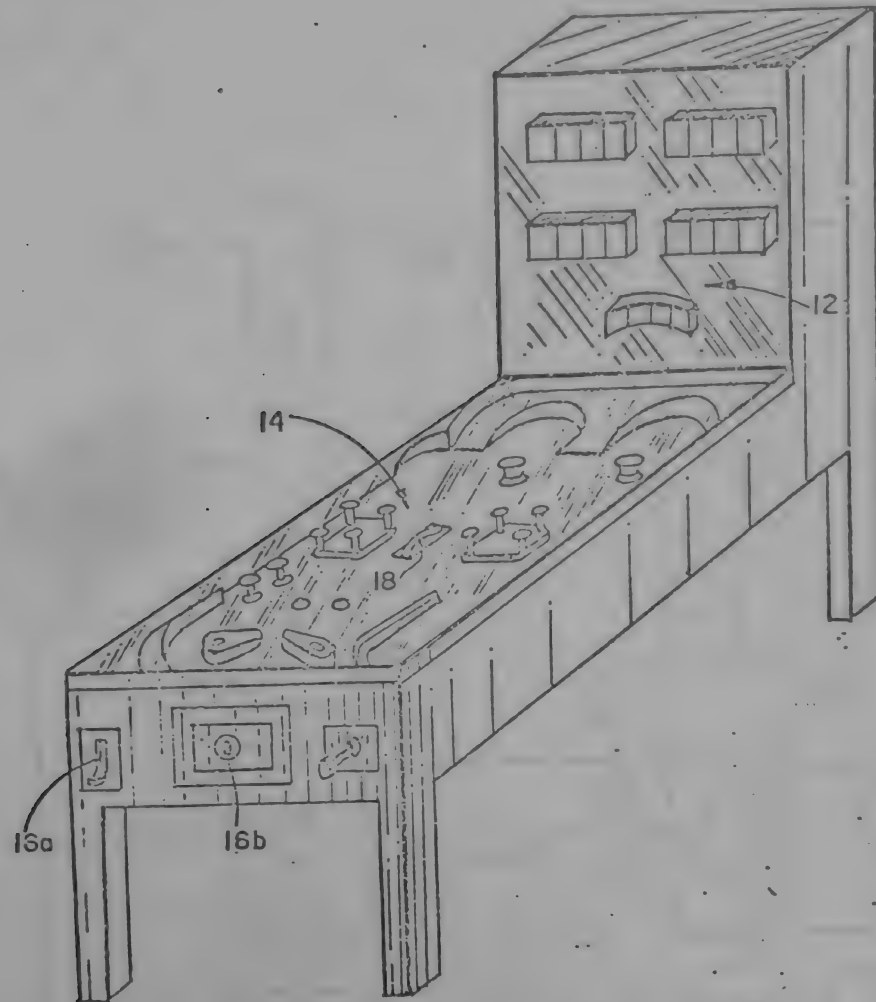


FIG. 1

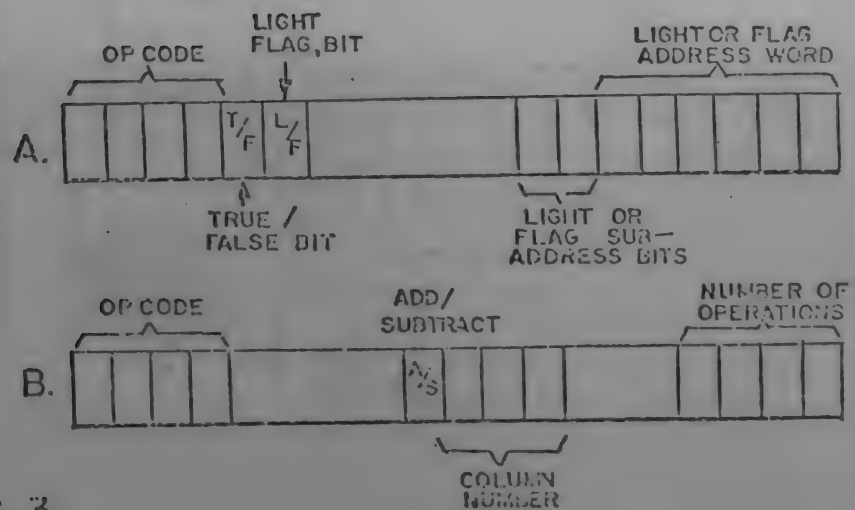
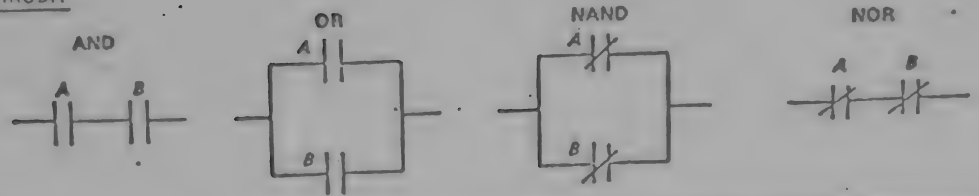


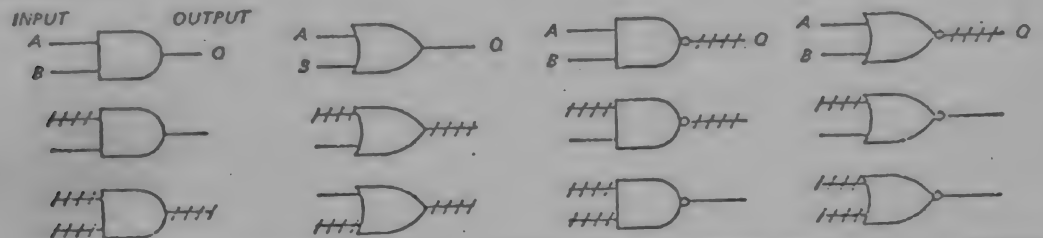
FIG. 3



RELAY CIRCUIT



LOGIC SYMBOL



PGOL EQUIVALENT

IF BIT A ON
 AND BIT B ON
 SET Q

IF BIT A ON
 OR BIT B ON
 SET Q

IF BIT A OFF
 OR BIT B OFF
 SET Q

IF BIT A OFF
 AND BIT B OFF
 SET Q

FIG. 4

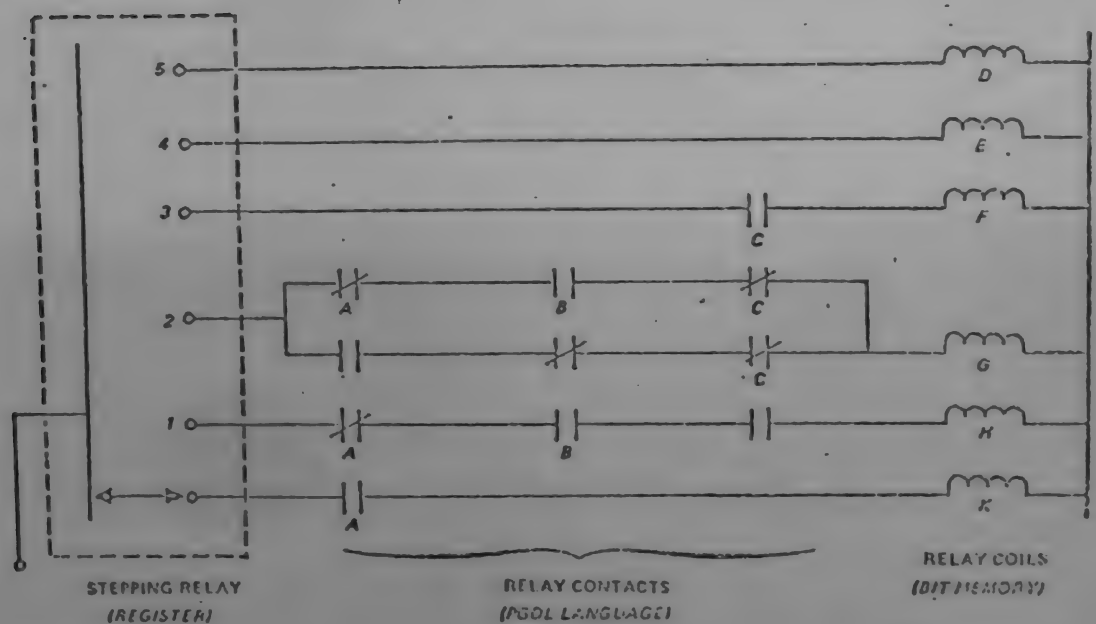


FIG. 5

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

BALLY MANUFACTURING CORPORATION,
a Delaware corporation,

Plaintiff/Counterdefendant,

vs.

D. GOTTLIEB & CO., a corporation, WILLIAMS
ELECTRONICS, INC., a corporation, and
ROCKWELL INTERNATIONAL CORPORATION,

Defendants/Counterplaintiffs,

BALLY MANUFACTURING CORPORATION,
a Delaware corporation,

Plaintiff,

vs.

GAME PLAN, INCORPORATED, a Delaware
corporation,

Defendant.

No. 78 C 2246

No. 79 C 713

Tuesday, January 15, 1980
10:15 a.m.

PRESENT:

MR. WELSH
MR. KATZ
MR. SCHNAYER

MR. GOLDENBERG

MR. LYNCH
MR. HARDING

MR. MEYERS

(The taking of the deposition of MARION F.
BRACHA was resumed at 135 South LaSalle Street,
Room 1540, Chicago, Illinois, as follows:)

Q Well, do you recall a patent application filed at any time in which you were named with Mr. Englehardt as a co-inventor pertaining to pinball games?

A Yes.

Q You do not know when that was?

A I don't recall.

Q I show you a document and represent to you and Mr. Welsh that it is a copy, a certified copy, of a patent application, serial number 633,470 filed in the United States Patent Office, Patent and Trademark Office, on November 19, 1975.

I ask you, sir, in looking at that document, does that refresh your recollection on when the patent application was filed with you and Mr. Englehardt as co-inventors pertaining to microcomputer control of pinball games?

MR. WELSH: Are you going to mark this as an exhibit?

MR. GOLDENBERG: I would be delighted to do that. I do not know what my next exhibit is.

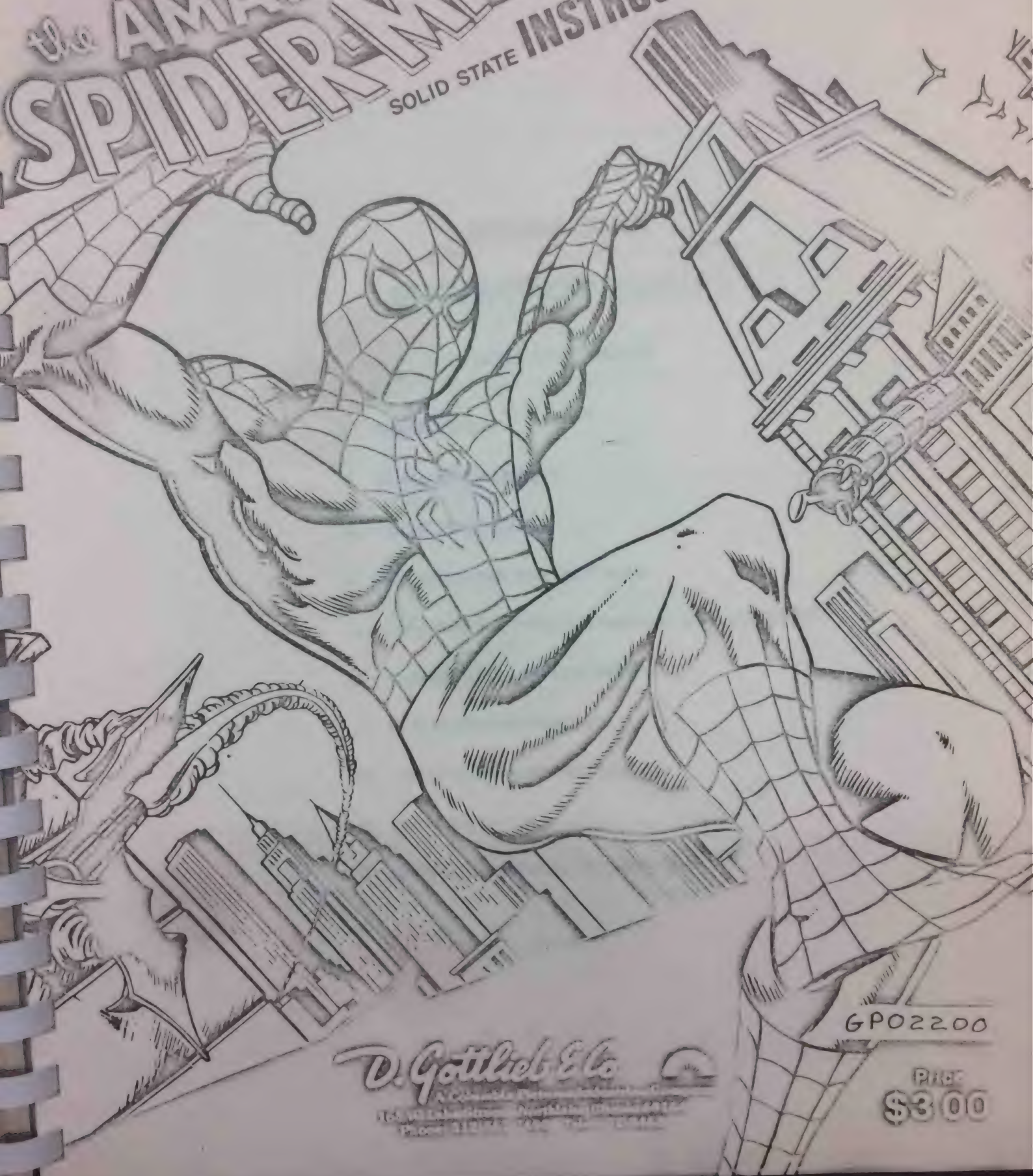
MR. SCHNAYER: Can I examine that, please?

MR. GOLDENBERG: Well, you can see it later.

MR. SCHNAYER: I just want to take a quick look through it.

MARVEL'S The AMAZING SPIDER-MAN

SOLID STATE INSTRUCTION MANUAL



GP02200

D. Gottlieb & Co.
A Division of
165 West 42nd Street, New York, N.Y. 10018
Phone 212-675-1000

Price
\$3.00

SPIDER-MAN

INSTRUCTION MANUAL

TABLE OF CONTENTS

- I. INSTALLATION**
- II. GAME ADJUSTMENTS**
- III. GAME OPERATION**
- IV. BOOKKEEPING AND SELF-TEST**
- V. OPTIONAL ELECTRO-MECHANICAL COIN COUNTERS**
- VI. SWITCH AND LAMP ASSIGNMENT**
- VII. PLAYBOARD INFORMATION**
- VIII. CABLE PLUG WIRE ASSIGNMENTS**
- IX. PARTS LIST**
- X. WIRING AND SCHEMATIC DIAGRAMS**

I. INSTALLATION

To assemble the game, first bolt the legs to the cabinet. Feed the line cord through the slot provided in the pedestal. Place the lightbox atop the pedestal and engage the holding brackets.

To remove glass, insert key and unlock. Lift glass up and swing bottom out. Loosen and lower the shipping bracket at top center of lightbox insert panel. Lift panel up and then swing out. Secure lightbox to cabinet with the four bolts and washers provided.

Connect all cables and secure with cable clamps provided. Inspect the following **before** plugging in line cord:

1. Check that cables are clear of moving parts.
2. Look for any disconnected wires.
3. Check switches for loose solder or other foreign matter.
4. Be certain all fuses are firmly seated.
5. Check the transformers for foreign matter across the terminals.
6. Be sure that the transformer wiring corresponds to the supply voltage.
7. Check the setting of the tilt switch on the underside of the playfield. One blade of this switch is free-floating with a weight on the end.

After levelling the machine, adjust the plumb-bob tilt (on left side of cabinet near front door) to the sensitivity desired.

II. GAME ADJUSTMENTS

A. PLAYFIELD ADJUSTMENTS

The game is shipped with adjustable posts in the position found to be suitable for the greatest number of players. Therefore the posts should not be changed unless the need is clearly evident.

The "conservative" (easier entry) position decreases playing time and scoring while the "liberal" position has the opposite effect.

B. LIGHTBOX ADJUSTMENTS

There are 32 switches on the control board which permit adjustment of the game parameters. These switches are contained in four packages of eight switches each, as shown below:

S1 - S8	S9 - S16	S17 - S24	S25 - S32
---------	----------	-----------	-----------

SWITCHES				COIN CHUTE ADJUSTMENTS
S1	S2	S3	S4	Left Chute
S5	S6	S7	S8	Right Chute
S9	S10	S11	S12	Center Chute

NOTE: FOR GERMAN GAMES ONLY, switches S5-S8 adjust the center chute and switches S9-S12 adjust the right chute.

				COINS/CREDITS
OFF	OFF	OFF	OFF	1/1
OFF	OFF	OFF	ON	1/2
OFF	OFF	ON	OFF	1/3
OFF	OFF	ON	ON	1/4
OFF	ON	OFF	OFF	1/5
OFF	ON	OFF	ON	1/6
OFF	ON	ON	OFF	1/7
OFF	ON	ON	ON	1/8
ON	OFF	OFF	OFF	1/9
ON	OFF	OFF	ON	2/1*
ON	OFF	ON	OFF	2/2*
ON	OFF	ON	ON	2/3*
ON	ON	OFF	OFF	2/4*
ON	ON	OFF	ON	2/5*
ON	ON	ON	OFF	1/1 and 2/3
ON	ON	ON	ON	3/1*

*NO CREDITS UNTIL LAST COIN IS INSERTED

SWITCH 13 **EXTRA CREDITS**
 ON Adds 9 credits to center coin chute setting
 OFF No effect
 NOTE: FOR GERMAN GAMES ONLY, Switch 13 adds 9 credits to the right coin chute setting, when ON.

SWITCH 14 **COIN CHUTE CONTROL**
 ON Left and Right Chutes Same
 OFF Left and Right Chutes Separate
 NOTE: FOR GERMAN GAMES ONLY, Switch 14 controls the left and center coin chutes.

SWITCHES **MAXIMUM CREDITS**
 15 16
 OFF OFF 8
 OFF ON 10
 ON OFF 15
 ON ON 25

SWITCH 17 **BALLS PER GAME**
 ON 3
 OFF 5

SWITCH 18 **MATCH FEATURE**
 ON ON
 OFF OFF

SWITCH 19 **REPLAY LIMIT**
 ON Limits each player to one replay per game
 OFF No replay limit

SWITCH 20 **NOVELTY MODE**
 ON Playfield SPECIAL and EXTRA BALL features award 50,000 points and 5 knocks. High score, high game to date, and match features disabled.
 OFF Normal game mode.

NOTE: SWITCH 20 overrides SWITCH 21

SWITCH 21 **GAME MODE**
 ON Extra Ball
 OFF Replay
 NOTE: IF SWITCH 21 is ON, the high game to date and match awards are disabled.

SWITCH 22 **PLAYFIELD SPECIAL**
 ON Awards Extra Ball
 OFF Awards Special

SWITCHES **HIGH GAME TO DATE**
 23 24
 OFF OFF Not displayed — no award
 OFF ON Displayed — No award
 ON OFF Displayed — awards 2 replays
 ON ON Displayed — awards 3 replays

SWITCH 25 **SOUND WHEN SCORING?**
 ON Yes
 OFF No

SWITCH 26 **REPLAY BUTTON TUNE?**
 ON ☒ Yes
 OFF No

SWITCH 27 **COIN SWITCH TUNE?**
 ON Yes
 OFF No

SWITCH 28 **CREDITS DISPLAYED?**
 ON Yes
 OFF No

SWITCH 29 **TILT PENALTY**
 ON Ball in play only
 OFF Game over

SWITCH 30 **ATTRACT FEATURES**
 ON ON
 OFF OFF

SWITCHES 31, 32

(Not used on Game #653)

Liberal/Conservative

C. ELECTRONIC SOUND ADJUSTMENTS

There are two switches on the SOUND BOARD which allow variation:

SWITCH S1	
OFF	SOUND MODE
ON	TONE MODE
SWITCH S2	
OFF	NO ATTRACT TUNE
ON	ATTRACT TUNE PLAYED EVERY 6 MINUTES

The volume control is on the bottom panel in the cabinet and is accessible from the front door opening.

III. GAME OPERATION

With the line cord unplugged drop a coin into one of the chutes. It should be rejected. Plug the line cord ONLY into a properly grounded 3-wire receptacle of the correct voltage. Turn on the game by pressing the main switch located on the cabinet bottom near the front right corner.

After a five second delay the relays will pulse and the score displays will light and show all zeros. The credit display will show the number of credits remaining and the ball in play display will be blank. If the credits fail to light, turn off the game and inspect the ball roll assembly switch and the front door slam switch. They are both normally closed.

Five seconds after the score displays light, they will flash the High Game to Date score for one second. This cycle continues until the game is started. A number of playfield lights controlled by the MPU will be flashed to create an attract mode.

Insert coins into each chute and note that the correct number of credits are added on the credit display according to the information on the coin entrance plate. Press the replay button to reset the game: the ball should now be at the shooter. The first player score reads zero and flashes, indicating that that player is now scoring. The other player displays are blank and a one appears on the ball in play display. Additional players are indicated by a zero showing in each corresponding player display. After the maximum number of players has been added, or when the credit display reads zero, the replay button has no effect.

When the ball enters the outhole the bonus is scored, the ball is kicked to the shooter, and the display of the player now scoring begins to flash and continues to flash until a score is made. When the Shoot Again light is lit neither the player designation (flashing display) nor the ball in play display changes when the ball enters the outhole. Only one extra ball per ball in play can be given.

The number of balls per game is adjustable. When the last ball enters the outhole, the Game Over and Number to Match lights come on. A random number appears in the ball in play display and if this number matches the last two digits in any player's score a replay is awarded. At this time a High Game to Date score is periodically flashed in all player displays. When a score higher than this is achieved, an award dependent on switches 23 and 24 is given.

Tilting the game results in a penalty depending on the setting of switch 29. There is a normally closed switch on the front door and one on the ball roll assembly. If either of these switches opens from raising the front of the game or pounding the front door, the entire game is ended. The Game Over light comes on and for three seconds the entire switch matrix is inactive.

Additional players can be added at any time the first ball is still in play.

IV. BOOKKEEPING AND SELF-TEST

The circuitry in this game helps the operator perform many bookkeeping functions. The information is shown one step at a time on the first player score display while the step number is shown in the credit display. Pressing the play/test button on the front door begins the bookkeeping and advances it to the next step each time the button is pressed. If the button is not pressed within sixty seconds of each step, the game returns to the attract mode.

STEP NUMBER	INFORMATION SHOWN
00	NONE
01	TOTAL COINS THROUGH LEFT COIN CHUTE
02	TOTAL COINS THROUGH RIGHT COIN CHUTE
NOTE: IF CONTROL BOARD SWITCH 14 IS ON, STEPS 01 AND 02 ARE ADDED TOGETHER AND DISPLAYED IN STEP 01.	
03	TOTAL COINS THROUGH CENTER COIN CHUTE
NOTE: FOR GERMAN GAMES ONLY, STEP 02 DISPLAYS TOTAL COINS THROUGH CENTER COIN CHUTE AND STEP 03 DISPLAYS TOTAL COINS THROUGH RIGHT COIN CHUTE.	
04	TOTAL PLAYS
05	TOTAL REPLAYS
06	GAME PERCENTAGE (Replays ÷ total plays)
NOTE: IF STEP 06 IS RESET, STEPS 04 AND 05 MUST ALSO BE RESET.	
07	EXTRA BALLS
08	TILTS
09	SLAMS
10	Number of times High Game to Date has been incremented to reach its present value.
11	First High Score level
12	Second High Score level
13	Third High Score level
14	High Game to Date score
15	Average playing time per game PLAYER 1 shows minutes PLAYER 2 shows seconds
NOTE: IF STEP 15 IS RESET, STEP 04 MUST ALSO BE RESET.	

All bookkeeping information is checked against itself to insure that it is correct. If the data changes for any reason, such as a dead battery, that information will be flashing while it is displayed.

The data in any bookkeeping step may be reset to zero while it is displayed by pressing the replay button on the front door. The play/test button must then be pressed to enter the zero into memory.

TO CHANGE HIGH SCORE LEVELS OR HIGH GAME TO DATE SCORE:

1. Press the play/test button on the front door to advance to step 11. (1st high score level).
2. Reset the score by pressing the replay button on the front door.
3. Release the replay button then hold it in again. This causes the score to advance by 10,000's. Hold in the replay button until the desired score is shown.

Enter the new score into memory by pressing the play/test button and advancing to the next step.

To return the attract mode at any time, actuate the slam switches, tilt switches, on-off power switch, or wait sixty seconds.

SELF-TEST FEATURES:

The self-test routine begins with STEP 16. To bypass the bookkeeping functions and advance directly to self-test, press the Replay button in STEP 00.

STEP NUMBER	
16	LAMP TEST Relays and coin lockout coil are pulsed, then all controlled lamps are turned on in sequence.
17	SOLENOID TEST Each controlled solenoid is pulsed while its number appears on the status display.

SOLENOID ASSIGNMENTS

NUMBER	FUNCTION
1	#2 Hole Kicker
2	#1 & #3 Hole Kickers
3	Left Coin Chute counter*
4	Right Coin Chute counter*
5	Left Target Bank Reset
6	Right Target Bank Reset
7	Center Coin Chute counter*
8	Knocker
9	Outhole

*coin counters are optional and are **NOT** pulsed during SOLENOID TEST.

NOTE: FOR GERMAN GAMES ONLY, SOLENOID #4 is assigned to the **center** coin chute counter and SOLENOID #7 is assigned to the **right** coin chute counter.

SWITCH TEST

- 18 All switches on the switch matrix are inspected. If all switches are open, 99 is displayed on the status display. If one or more switches are closed, their numbers will appear on the status displays.

CAUTION: TURN POWER OFF BEFORE MAKING ANY SWITCH ADJUSTMENTS!

DISPLAY TEST

- 19 Each digit of each display is turned on individually and all numbers 0-9 are sequenced.

MEMORY TEST

- 20 Each control board memory device is inspected. Any defective devices are indicated by part number on the PLAYER 1 score display.

Any of the tests in steps 16 through 20 may be repeated any number of times by pressing the replay button immediately after the test is completed.

V. OPTIONAL ELECTRO-MECHANICAL COIN COUNTERS

Electro-mechanical coin counters may be installed on the bottom board, if desired. Directly behind the seven position fuse block, solder lugs are provided which will connect the counters to the electronic circuitry.

1. Position the counter and secure it to the bottom board. Mounting holes are spotted in the bottom board for most standard 24 volt counters.
2. **CAUTION:** A 1N4004 diode must be connected across each counter with the cathode end connected to the solder lug with the RED-BLACK-BLACK wire.
3. Connect one counter lead to each of the two solder lugs provided for each counter.
4. The counter should increment once when the respective coin chute switch is closed.

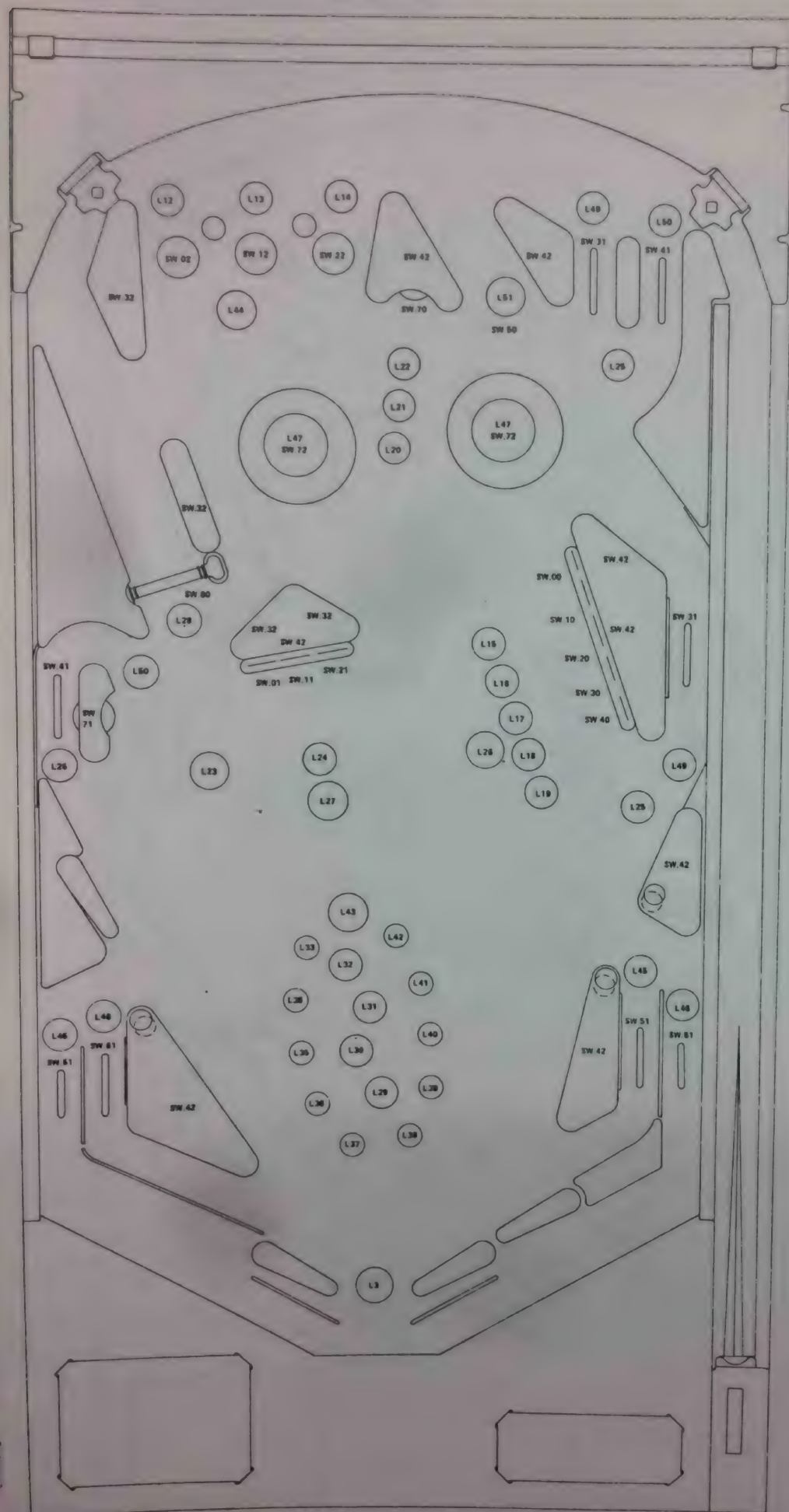
VI. SWITCH MATRIX AND LAMP LOCATION ASSIGNMENT

SWITCH MATRIX AND LAMP LOCATION SWITCHES ON MATRIX

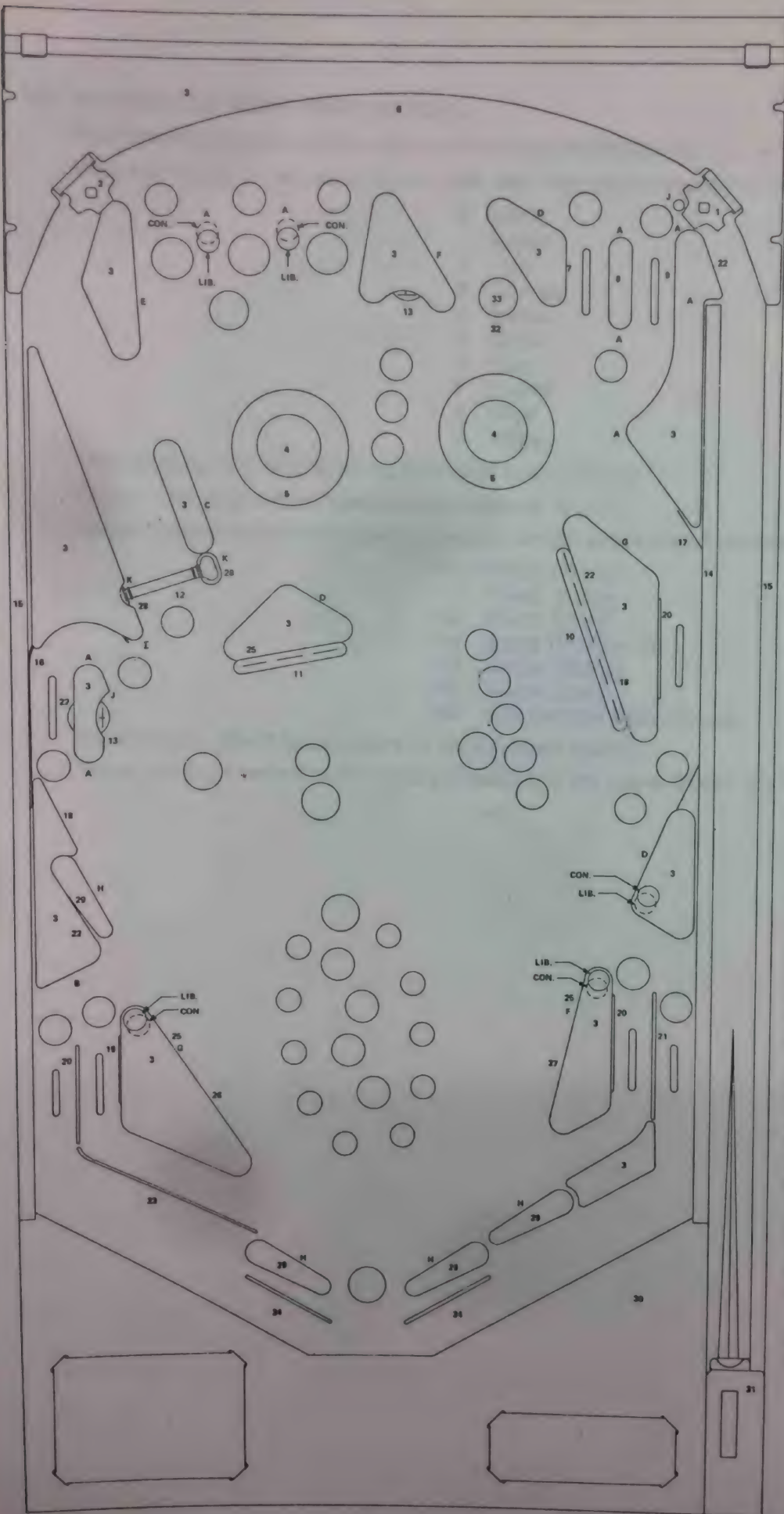
SW MATRIX NUMBER	SWITCH FUNCTION
00	#1 Right Drop Target
01	#1 Left Drop Target
02	#1 Hole
10	#2 Right Drop Target
11	#2 Left Drop Target
12	#2 Hole
20	#3 Right Drop Target
21	#3 Left Drop Target
22	#3 Hole
30	#4 Right Drop Target
31	A Rollover (2)
32	10 Point Contacts (4)
40	#5 Right Drop Target
41	B Rollover (2)
42	50 Point Contacts (6)
50	Kicking Rubber (2)
51	Rollover Button
51	Right Return Rollover
51	Left Outside Rollover
57	Tilt
60	Spin Target
61	Left Return Rollover
61	Right Outside Rollover
67	Outhole
70	Top Target
71	Side Target
72	Pop Bumpers (2)

CPU CONTROLLED LAMPS

LAMP NUMBER	LAMP FUNCTION
0	Game Over Relay
1	Tilt Relay
2	Coin Lockout Relay
3	Same Player Shoots Again (Lightbox and Playfield)
4	1st Player
5	2nd Player
6	3rd Player
7	4th Player
10	High Game To Date (Lamp in Lightbox)
11	Game Over (Lamp in Lightbox)
12	#1 Hole Kicker
13	#2 Hole Kicker
14	#3 Hole Kicker
15	#1 Right Drop Target
16	#2 Right Drop Target
17	#3 Right Drop Target
18	#4 Right Drop Target
19	#5 Right Drop Target
20	#1 Top Target
21	#2 Top Target
22	#3 Top Target
23	Special
24	Advance Multiplier
25	Multi-Bonus (3)
26	Right Extra Ball
27	Left Extra Ball
28	Spin Target
29	2X
30	3X
31	4X
32	5X
33	1000 Bonus
34	2000 Bonus
35	3000 Bonus
36	4000 Bonus
37	5000 Bonus
38	6000 Bonus
39	7000 Bonus
40	8000 Bonus
41	9000 Bonus
42	10 000 Bonus
43	20 000 Bonus
44	Scores Bonus
45	Right Return Rollover
45	Left Outside Rollover
46	Left Return Rollover
46	Right Outside Rollover
47	Pop Bumpers (2)
49	A Rollovers (2)
50	B Rollovers (2)
51	Rollover Button



VII. PLAYBOARD INFORMATION



PLAYBOARD INFORMATION

RUBBER RINGS

- A—A-10217 (9)
- B—A-10219 (1)
- C—A-10220 (1)
- D—A-10221 (3)
- E—A-10222 (1)
- F—A-10223 (2)
- G—A-10224 (2)
- H—A-13151 (4)
- I—A-14793 (1)
- J—A-15705 (2)
- K—A-17493 (2)

PARTS LIST

1. A-19645 Ball Gate Right.
2. A-19646 Ball Gate Left.
3. D-19736 Plastic Shield Set.
4. Red Pop Bumpers A-13905 and A-19771
Cap Stamped in Blue. (2)
5. C-10433 Pop Bumper Skirt Red. (2)
6. D-19649 Arch Rail.
7. A-9393 Yellow Plastic Guide Rail.
8. A-9396 Yellow Plastic Guide Rail.
9. A-9397 Yellow Plastic Guide Rail.
10. 5 Pos. Right Drop Target Bank,
A-19838 Stamped in Black.
11. 3 Pos. Left Drop Target Bank
A-19838 Stamped in Black.
12. A-19841 Spinning Target Stamped
in Black.
13. A-19837 Target Stamped in Black. (2)
14. C-19647 Center Wood Rail.
15. C-19648 Right and Left Outside Rails. (2)
16. B-13602 Metal Flat Rail.
17. B-15609 Metal Flat Rail.
18. A-3722 Ball Guide Rail. (2)
19. A-4831 Ball Guide Rail. (1)
20. A-4832 Ball Guide Rail. (3)
21. A-4833 Ball Guide Rail. (1)
22. A-6931 Ball Guide Rail. (4)
23. A-13584 Ball Guide Rail. (1)
24. A-13798 Ball Snubber Rail. (2)
25. A-18070 Ball Guide Rail. (3)
26. A-15836 Left Kicking Rubber.
27. A-15838 Right Kicking Rubber.
28. C-17492 White Siamese Post. (2)
29. C-13150 White Jumbo Flipper. (4)
30. E-18793 Card Holder.
31. C-9767 Ball Shooter Gage.
32. D-11966 Rollover Insert—Red.
33. D-11968 Rollover Button—White.
- C-11561 Clear 1" High Post. (35)
- C-11562 Clear 1-3/16" High Post. (4)
- A-14487 Split Post Base. (8)
- A-14488 Split Post Cap. (8)

CON. = CONSERVATIVE.
LIB. = LIBERAL.

VIII. CABLE PLUG WIRE ASSIGNMENTS

The following lists provide wire color and function information for each wire of each connector in the game.

Wire colors are shown as numbers. Use the chart below to convert to colors.

- 0 Black
- 1 Brown
- 2 Red
- 3 Orange
- 4 Yellow
- 5 Green
- 6 Blue
- 7 Purple
- 8 Slate
- 9 White

For example, 688 is a BLUE-SLATE-SLATE striped wire.

Printed Circuit Board connectors are shown as AX-JX.

Use the following chart to determine which printed circuit board applies:

- A1 Control Board
- A2 Power Supply
- A3 Driver Board
- A4 Score Displays (4)
- A5 Status Display
- A6 Sound Board
- A8 Pop Bumper Driver Board

For example, A3-J3 is connector J3 on the driver board.

There are eight male/female cable connectors in the game. These are shown as A7-JX/PX.

A1-J1		
PIN	WIRE COLOR	FUNCTION
1	*688	+5VDC
2	*688	+5VDC
3	—	SPARE
4	*54	GROUND
5	*54	GROUND

A1-J2		
PIN	WIRE COLOR	FUNCTION
1	300	aA
2	311	bA
3	322	cA
4	333	dA
5	344	eA
6	355	fA
7	366	gA
8	377	hA
9	600	aB
10	611	bB
11	622	cB
12	633	dB
13	644	eB
14	655	fB
15	666	gB
16	677	hB
17	800	aC
18	811	bC
19	822	cC
20	833	dC
21	844	eC
22	855	fC
23	866	gC
24	877	hC

A1-J3		
PIN	WIRE COLOR	FUNCTION
1	400	D1
2	411	D2
3	422	D3
4	433	D4
5	444	D5
6	455	D6
7	466	D7
8	477	D8
9	700	D9
10	711	D10
11	722	D11
12	733	D12
13	744	D13
14	755	D14
15	766	D15
16	777	D16
17	—	SPARE

A1-J4		
PIN	WIRE COLOR	FUNCTION
1	*54	GROUND
2	*688	+5VDC
3	9	DS2
4	9	LD3
5	9	LD4
6	9	LD2
7	9	LD1
8	—	SPARE
9	—	SPARE
10	—	SPARE
11	—	SPARE
12	—	SPARE
13	—	SPARE
14	—	SPARE
15	—	SPARE
16	—	SPARE
17	—	SPARE
18	—	KEY
19	—	SPARE
20	—	SPARE
21	9	KNOCKER
22	9	3RD COUNTER
23	9	2ND COUNTER
24	9	1ST COUNTER
A	*54	GROUND (SPARE)
B	*688	+5VDC (SPARE)
C	9	DS1
D	9	DS4
E	9	DS3
F	9	DS6
H	9	DS5
J	9	DS8
K	9	DS7
L	9	DS10
M	9	DS9
N	9	DS11
P	9	DS12
R	9	SOLENOID 5
S	9	SOLENOID 1
T	9	OUTHOLE
U	9	SOLENOID 6
V	—	(KEY)
W	—	SPARE
X	9	SOLENOID 2
Y	9	SOUND 8
Z	9	SOUND 4
A	9	SOUND 2
B	9	SOUND 1

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A1-J5

PIN	WIRE COLOR	FUNCTION
1	677	RETURN 7
2	400	STROBE 0
3	411	STROBE 1
4	422	STROBE 2
5	433	STROBE 3
6	*444	STROBE 4
7	455	STROBE 5
8	666	RETURN 6
9	477	STROBE 7
10	700	SLAM SW.

A1-J6

PIN	WIRE COLOR	FUNCTION
1	400	STROBE 0
2	411	STROBE 1
3	422	STROBE 2
4	433	STROBE 3
5	444	STROBE 4
6	455	STROBE 5
7	466	STROBE 6
8	477	STROBE 7
9	9	GROUND
10	600	RETURN 0
11	611	RETURN 1
12	622	RETURN 2
13	633	RETURN 3
14	644	RETURN 4
15	655	RETURN 5
16	666	RETURN 6
17	677	RETURN 7
18	688	+5VDC
19	—	SPARE

A2-J1

PIN	WIRE COLOR	FUNCTION
1	(#16GA) 200	12VDC
2	(#16GA) 54	GROUND
3	—	SPARE
4	—	(KEY)
5	688	+5VDC
6	166	+5VDC offset
7	100	60V
8	111	60V RETURN
9	133	+8VDC offset

A2-J2

PIN	WIRE COLOR	FUNCTION
1	*688	+5VDC
2	*688	+5VDC
3	*54	GROUND
4	*54	GROUND
5	—	(KEY)
6	—	SPARE

A2-J3

PIN	WIRE COLOR	FUNCTION
1	044	+60VDC
2	—	(KEY)
3	055	+42VDC
4	54	GROUND
5	54	GROUND
6	688	+5VDC (SPARE)
7	688	+5VDC

A3-J1

PIN	WIRE COLOR	FUNCTION
1	*54	GROUND
2	*688	+5VDC
3	9	DS2
4	9	LD3
5	9	LD4
6	9	LD2
7	9	LD1
8	—	SPARE
9	—	SPARE
10	—	SPARE
11	—	SPARE
12	—	SPARE
13	—	SPARE
14	—	SPARE
15	—	SPARE
16	—	SPARE
17	—	SPARE
18	—	SPARE
19	—	(KEY)
20	—	SPARE
21	9	KNOCKER
22	9	3RD COUNTER
23	9	2ND COUNTER
24	9	1ST COUNTER
A	*54	GROUND (SPARE)
B	*688	+5VDC (SPARE)
C	9	DS1
D	9	DS4
E	9	DS3
F	9	DS6
H	9	DS5
J	9	DS8
K	9	DS7
L	9	DS10
M	9	DS9
N	9	DS11
P	9	DS12
R	9	SOLENOID 5
S	9	SOLENOID 1
T	9	OUTHOLE
U	9	SOLENOID 6
V	—	SPARE
W	—	(KEY)
X	9	SOLENOID 2
Y	9	SOUND 8
Z	9	SOUND 4
<u>A</u>	9	SOUND 2
<u>B</u>	9	SOUND 1

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A3-J2

PIN	WIRE COLOR	FUNCTION
1	588	SHOOT AGAIN LAMP
2	500	PLAYER 1 LAMP
3	511	PLAYER 2 LAMP
4	533	PLAYER 4 LAMP
5	522	PLAYER 3 LAMP
6	*54	GROUND
7	577	HIGH GAME TO DATE LAMP
8	566	GAME OVER LAMP
9	—	SPARE
10	—	SPARE

A3-J3

PIN	WIRE COLOR	FUNCTION
1	*54	SPARE GROUND
2	777	L43
3	755	L41
4	744	L40
5	544	L32
6	555	L33
7	577	L35
8	—	KEY
9	344	L24
10	355	L25
11	377	L27
12	366	L26
13	144	L16
14	155	L17
15	177	L19
16	166	L18
17	(16GA) 54	GROUND (L20-L27)
18	322	L22
19	333	L23
20	311	L21
21	300	L20
22	122	L14
23	133	L15
24	111	L13
25	100	L12
A	*54	SPARE GROUND
B	*688	+5VDC (SPARE)
C	*54	GROUND (L44-L51)
D	800	L44
E	844	L48
F	811	L45
H	855	L49
J	—	KEY
K	566	L34
L	—	SPARE
M	833	L47
N	877	L51
P	822	L46
R	866	L50

A3-J3 continued

PIN	WIRE COLOR	FUNCTION
S	*54	GROUND (L40-L43)
T	766	L42
U	(16GA) 54	GROUND (L28-L35)
V	522	L30
W	533	L31
X	511	L29
Y	500	L28
Z	(16GA) 54	GROUND (L12-L19)
Ā	288	GAME OVER RELAY
Ḃ	277	TILT RELAY
Ĉ	588	SHOOT AGAIN LAMP

A3-J4

PIN	WIRE COLOR	FUNCTION
1	700	L36
2	711	L37
3	733	L39
4	722	L38
5	*54	GROUND (L36-L39)
6	*211	SOLENOID 5
7	*266	SOLENOID 1
8	*244	OUTHOLE (SOL. 9)
9	*54	GROUND (SOL. 1, 9)
10	*54	GROUND (SOL. 2)
11	*54	GROUND (SOL. 6)
12	*233	SOLENOID 6
13	*200	SOLENOID 2
14	*54	GROUND (SOL. 5)
15	*54	SPARE GROUND

A3-J5

PIN	WIRE COLOR	FUNCTION
1	733	SOUND 4
2	877	COIN LOCKOUT COIL
3	54	GROUND (KNOCKER)
4	688	+5VDC (SPARE)
5	722	SOUND 2
6	711	SOUND 1
7	744	SOUND 8
8	888	KNOCKER

A3-J6

PIN	WIRE COLOR	FUNCTION
1	633	2ND COUNTER
2	644	3RD COUNTER
3	655	1ST COUNTER
4	54	GROUND

continued

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

1A4-J1

PIN	WIRE COLOR	FUNCTION
1	455	D6
2	444	D5
3	433	D4
4	422	D3
5	411	D2
6	400	D1
7	377	hA
8	366	gA
9	355	fA
10	344	eA
11	333	dA
12	322	cA
13	311	bA
14	300	aA
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

2A4-J1

PIN	WIRE COLOR	FUNCTION
1	733	D12
2	722	D11
3	711	D10
4	700	D9
5	477	D8
6	466	D7
7	377	hA
8	366	gA
9	355	fA
10	344	eA
11	333	dA
12	322	cA
13	311	bA
14	300	aA
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

3A4-J1

PIN	WIRE COLOR	FUNCTION
1	455	D6
2	444	D5
3	433	D4
4	422	D3
5	411	D2
6	400	D1
7	677	hB
8	666	gB
9	655	fB
10	644	eB
11	633	dB
12	622	cB
13	611	bB
14	600	aB
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

4A4-J1

PIN	WIRE COLOR	FUNCTION
1	733	D12
2	722	D11
3	711	D10
4	700	D9
5	477	D8
6	466	D7
7	677	hB
8	666	gB
9	655	fB
10	644	eB
11	633	dB
12	622	cB
13	611	bB
14	600	aB
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A5-J1

PIN	WIRE COLOR	FUNCTION
1	—	SPARE
2	777	D16
3	766	D15
4	—	SPARE
5	755	D14
6	744	D13
7	822	cC
8	811	bC
9	877	hC
10	866	gC
11	855	fC
12	844	eC
13	833	dC
14	800	aC
15	155	3vAC
16	177	3vAC RETURN
17	055	+42vDC
18	688	+5vDC
19	54	GROUND

A6-J1

PIN	WIRE COLOR	FUNCTION
1	200	+12vDC
2	—	SPARE
3	333	AC
4	344	AC RETURN
5	688	+5vDC
6	54	GROUND
7	011	SPEAKER OUTPUT
8	711	SOUND 1
9	722	SOUND 2
10	—	SPARE
11	733	SOUND 4
12	744	SOUND 8

A7-J1/P1

PIN	WIRE COLOR	FUNCTION
1	677	RETURN 7
2	500	STROBE 0
3	511	STROBE 1
4	533	STROBE 3
5	522	STROBE 2
6	544	STROBE 4
7	555	STROBE 5
8	—	SPARE
9	—	SPARE
10	700	ANTI-CHEAT SW.
11	9	ANTI-CHEAT SW. (GND)
12	*54	EARTH GROUND

A7-J2/P2

PIN	WIRE COLOR	FUNCTION
1	*066	COIN CHUTE LIGHTS
2	*000	COIN CHUTE LIGHTS RETURN
3	*055	LEFT FLIPPER SWITCH
4	*388	FLIPPER SWITCH RETURN
5	222	+24vDC
6	877	COIN LOCKOUT

A7-J3/P3

PIN	WIRE COLOR	FUNCTION
1	*122	5VAC
2	*144	5VAC RETURN
3	155	3VAC
4	177	3VAC RETURN
5	*54	LAMP GROUND
6		SPARE
7	(16GA) 077	6.3 VAC
8	(16GA) 000	6.3 VAC RETURN
9	*255	+6vDC

A7-J4/P4

PIN	WIRE COLOR	FUNCTION
1	*54	GROUND
2	*54	GROUND
3	*54	GROUND
4	*54	GROUND
5	*54	GROUND
6	*54	GROUND
7	*54	GROUND
8	*54	GROUND
9	*54	GROUND
10	*54	GROUND
11	*54	GROUND
12	—	SPARE

A7-J5/P5

PIN	WIRE COLOR	FUNCTION
1	(16GA) 255	+6 VDC
2	(16GA) 54	GROUND
3	(16GA) 54	GROUND
4	(16GA) 54	GROUND
5	(16GA) 54	GROUND
6	(16GA) 222	+24VDC
7	*388	FLIPPER SW. RETURN
8	*388	FLIPPER SW. RETURN
9	*055	LEFT FLIPPER SWITCH
10	*044	RIGHT FLIPPER SWITCH
11	(16GA) 066	6.3VAC
12	(16GA) 000	6.3VAC RETURN
13	*277	25VAC
14	*288	25VAC RETURN
15	—	SPARE

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A7-J6/P6

PIN	WIRE COLOR	FUNCTION
1	011	MATCH LIGHT
2	022	TILT LIGHT
3	033	BALL IN PLAY LIGHT
4	—	SPARE

A7-J7/P7

PIN	WIRE COLOR	FUNCTION
1	400	STROBE 0
2	433	STROBE 3
3	477	STROBE 7
4	666	RETURN 6
5	677	RETURN 7
6	(#16GA) 54	GROUND
7	—	SPARE
8	777	AC INPUT
9	788	AC INPUT

A7-J8/P8

PIN	WIRE COLOR	FUNCTION
1	022	SPEAKER
2	*54	GROUND
3	*54	EARTH GROUND
4	—	SPARE

1A8-J1

PIN	WIRE COLOR	FUNCTION
1	*188	COIL #1
2	*54	GROUND
3	—	KEY
4	077	SWITCH #1
5	688	+5VDC
6	9	DC GROUND

2 A8-J1

PIN	WIRE COLOR	FUNCTION
1	*488	COIL #2
2	*54	GROUND
3	—	KEY
4	011	SWITCH #2
5	688	+5VDC
6	9	DC GROUND

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

IX. PARTS LIST

CONTROL BOARD

PART NUMBER	DESCRIPTION
R6502-13	CPU—(U1)
R6532-18	RIOT—(U4, U5, U6)
R3273-12	ROM—(U2)
R3272-12	ROM—(U3)
P5101L-1	RAM/CMOS—(Z5)
640361-3	SOCKET—DIP, 24 PIN
SN7402N	IC—2 INPUT—"NOR"—(Z8)
SN7400N	IC—2 INPUT—"NAND"—(Z9, Z13, Z14)
SN7432N	IC—2 INPUT—"OR"—(Z15)
SN7404N	IC—HEX INVERTER—(*)
SN7416N	IC—HEX INVERTER—OC/HV—(Z29, Z30)
SN7417N	IC—HEX BUFFER—OC—(Z32)
SN74LS139N	IC—2 TO 4 DECODER—(Z28)
SN74175N	IC—"D" FLIP FLOP—(Z18, Z20, Z22)
SN7448N	IC—4 TO 7 DECODER—(Z19, Z21, Z23)
SN74154N	IC—4 TO 16 DECODER—(Z25, Z33)
SN7474N	IC—DUAL FLIP FLOP—(Z2)
SCL4528B	CMOS IC—DUAL 1 SHOT—(Z1)
SCL4081B	CMOS IC—QUAD 2 INPUT "AND"—(Z4)
1N4148	DIODE—GP—(CR1-CR35)
1N5225B or 1N5987B	ZENER DIODE—3.0V, 5%—(VR1)
326R10-002	BATTERY—3.6V—(BAT. 1)
333R08-001	CRYSTAL—3.579545 MHZ—(Y1)
131R06-001	SPACER, CORK
MPS A70	TRANSISTOR—PNP—(Q1, Q4)
341R31-005	DIP SWITCH PACK—8 POS.—(SW1-SW4)
	RESISTOR—62 Ω , 1/4W, 5%—(R7)
	CAPACITOR—.01 MICROFARAD, 50V—(C2, C4-C13, C15-C24, C26-C29, C31-C35)
	CAPACITOR—.1 MICROFARAD, 50V—(C3, C14, C25, C30)
	CAPACITOR—100 MICROFARAD, 10V—(C1)
	RESISTOR—3.0K Ω , 1/4W, 5%—(R1, R3, R6, R11-24, R42, R45, R46, R48, R51-R57)
	RESISTOR—2.0K Ω , 1/4W, 5%—(R4, R5, R44)
	RESISTOR—180 Ω , 1/4W, 5%—(R8, R50)
	RESISTOR—1K Ω , 1/4W, 5%—(R9)
	RESISTOR—2.7M Ω , 1/4W, 5%—(R10)
	RESISTOR—620 Ω , 1/4W, 5%—(R25-R33)
	RESISTOR—4.7K Ω , 1/4W, 5%—(R2, R34-R41)
	RESISTOR—5.6K Ω , 1/4W, 5%—(R43, R49)
	RESISTOR—24K Ω , 1/4W, 5%—(R47)
	CAPACITOR—10 MICROFARAD, 10V—(C36)
2N4400	TRANSISTOR—MOTOROLA—(Q2, Q3)
SN74LS05N	IC—OPEN COLLECTOR INVERTER—(Z10)
SN74LS04N	IC—HEX INVERTER—(Z7)
MM74C04 or SCL 4069B	IC—CMOS—(Z36)
640379-3	SOCKET—40 PIN—(TC1)
	*(Z3, Z11, Z12, Z16, Z17, Z24, Z26, Z27, Z34, Z35)

MASTER DRIVER BOARD

PART NUMBER

DESCRIPTION

43-03-4	INSULATOR—THERMALLOY
2N6043	TRANSISTOR—NPN—(Q53, Q59, Q60)
2N3055	TRANSISTOR—NPN—(Q58, Q62, Q64)
MPS-U45	TRANSISTOR—NPN—(Q1-Q4, Q13-Q32, Q45-Q52, Q54-Q57, Q61, Q63)
MPS-A13	TRANSISTOR—NPN—(Q5-Q12, Q33-Q44)
SN74175N	IC—QUAD "D" FLIP-FLOP—(Z1-Z12)
SN7404N	IC—HEX INVERTER—(Z32)
1N4148	DIODE—SILICON—(CR1-CR6)
	CAPACITOR—.01 MICROFARAD, 50V—(C2-C19)
	CAPACITOR—10 MICROFARAD, 10V—TANTALUM—(C1)
	RESISTOR—1000 Ω , 1/4W, 5%—(R1-R53, R61, R55, R56, R58, R59)
	RESISTOR—9.1 Ω , 1W, 5%—(R54, R57, R60)

POWER SUPPLY

PART NUMBER

DESCRIPTION

	HEATSINK MOUNTING PLATE
	SPACER—6—32 THREAD X 5/32
	SPACER—6—32 THREAD X 1/8
1N4004	DIODE—(CR1-CR4)
1N4759A	ZENER DIODE—62V, 1W, 5%—(CR5)
1N4746A	ZENER DIODE—18V, 1W, 5%—(CR6)
1N3445	ZENER DIODE—8.2V, 2W, 10%—(CR7)
1N4734A	ZENER DIODE—5.6V, 1W, 5%—(CR8)
SW4F013	TRANSISTOR—NPN—NATIONAL—(Q1)
2N5550	TRANSISTOR—NPN—(Q2)
PMD10K40	TRANSISTOR—LAMBDA—(Q3)
S107Y1	SILICON CONTROLLED RECTIFIER—(SCR1)
UA723CN	IC—14 PIN DIP—(IC1)
CM4-22	DIODE—LIGHT EMITTING—(LED1, LED2)
115R501A	POTENTIOMETER—500 Ω —CTS—(POT1)
	RESISTOR—1.3K Ω , 5W, 10%—(R1)
	RESISTOR—1K Ω , 1/4W, 5%—(R2, R9)
	RESISTOR—12K Ω , 1/2W, 5%—(R3)
	RESISTOR—33 Ω , 1W, 5%—(R4)
	RESISTOR—510 Ω , 1/4W, 5%—(R6, R13)
	RESISTOR—3.9K Ω , 1/4W, 5%—(R7)
	RESISTOR—10K Ω , 1/4W, 5%—(R8)
	RESISTOR—30 Ω , 2W, 5%—(R10)
	RESISTOR—2.2K Ω , 1/4W, 5%—(R11)
	RESISTOR—.33 Ω , 5W, 10%—(WIRE WOUND)—(R12)
	RESISTOR—10K Ω , 1/2W, 5%—(R5)
	RESISTOR—2K Ω , 1/4W, 5%—(R14)
	RESISTOR—100 Ω , 1/4W, 5%—(R15)
	RESISTOR—20 Ω , 1/4W, 5%—(R16)
	RESISTOR—620 Ω , 1/2W, 5%—(R17)
	RESISTOR—180 Ω , 1/4W, 5%—(R18)
	CAPACITOR—470 MICROFARAD, 100V—(C1)
	CAPACITOR—47 MICROFARAD, 100V—(C2)
	CAPACITOR—1000 PICOFARAD, 50V—(C3)
	CAPACITOR—470 MICROFARAD, 10V—(C4)
	CAPACITOR—.2 MICROFARAD, 16V, ^{+80%} _{-20%} —(C5)
	TURRET TERMINAL—(E1-E6)
	TURRET TERMINAL—(TP1-TP5, CR5)
1NS-3	INSULATOR
DM111	INSULATOR
G52-3	EYELET
	CONNECTOR—6 PIN—MOLEX—(J2)
	CONNECTOR—7 PIN—MOLEX—(J3)
	CONNECTOR—9 PIN—MOLEX—(J1)
	HEAT SINK—THERMALLOY

SOUND BOARD

PART NUMBER

DESCRIPTION

	RESISTOR—2.7K Ω , 1/4W, 5%—(R1, R2, R7)
	RESISTOR—2.7 Ω , 1/4W, 5%—(R9)
	RESISTOR—6.8K Ω , 1/4W, 5%—(R10)
	RESISTOR—430 Ω , 1/2W, 5%—(R11)
	RESISTOR—2.7M Ω , 1/4W, 5%—(R3)
	RESISTOR—1.8M Ω , 1/4W, 5%—(R4)
	RESISTOR—22.1K Ω , 1/4W, 1%—(R12)
	RESISTOR—10K Ω , 1/4W, 5%—(R6)
	RESISTOR—5.6K Ω , 1/4W, 5%—(R8)
	RESISTOR—270K Ω , 1/4W, 5%—(R5)
	RESISTOR—15K Ω , 1/4W, 5%—(R13)
	CAPACITOR—0.01 MICROFARAD, 100V, 20%—KEMET—(C1-C5)
	CAPACITOR—47 MICROFARAD, 25V—(C7, C9)
	CAPACITOR—470 MICROFARAD, 25V—(C8)
	CAPACITOR—0.1 MICROFARAD, 100V, 20%—KEMET—(C6, C10, C13, C17)
	CAPACITOR—10 PICO FARAD, 1000V, 5%—(C11)
	CAPACITOR—100 PICO FARAD, 250V, 20%—(C12)
	CAPACITOR—0.047 MICROFARAD, 25V, 20%—(C15)
	CAPACITOR—0.0033 MICROFARAD, 50V, 20%—(C16)
	CAPACITOR—10 MICROFARAD, 25V—(C14)
R6503	IC—CPU—(U1)
R6530C:R3014-14	IC—ROM/RAM/I/O—(U2)
SSS1408-6P	IC—DAC—(U3)
HM7643-5	IC—PROM—(U4)
NE555P	IC—TIMER—(U8)
SN7404N	IC—INVERTER—(U6, U7)
LM380N	IC—AMPLIFIER—(U5)
1N4004	DIODE—(CR1-CR4)
1N4742A	ZENER DIODE—12V, 1W, 5%—(CR5)
1N270	DIODE—(CR6)
76SB02	2 POSITION DIP SWITCH—(S1, S2)
EVQ-PAR-11K	PUSH BUTTON SWITCH—(S3)
640359-1	SOCKET, 18 PIN (PROM SOCKET)

POP BUMPER DRIVER BOARD

PART NUMBER

DESCRIPTION

	CAPACITOR—47 MICROFARAD, 10V—(C4)
	CAPACITOR—0.01 MICROFARAD, 100V, 20%—(C1, C2)
	CAPACITOR—4.7 MICROFARAD, 10V, 10%—(C3)
	RESISTOR—1.5K Ω , 1/4W, 5%—(R1)
	RESISTOR—12K Ω , 1/4W, 5%—(R2)
	RESISTOR—220 Ω , 1/4W, 5%—(R3)
	DIODE—(CR1, CR2)
1N4148	IC—(Z1)
SN74121N	IC—(Z2)
SN7416N	TRANSISTOR—LAMBDA—(Q1)
PMD10K60	CONNECTOR—(J1)
09-65-1061	

6-DIGIT DISPLAY (SPRAGUE DRIVERS)

QUANTITY	NUMBER	DESCRIPTION
1	RC20GF103	Resistor—10K Ω , 1/2W, 5% (R1)
1	TE1400	Capacitor—1 Microfarad, 100V (C3)
2	C320C103MIR5CA	Capacitor—0.01 Microfarad, 100V—Kemet (C1, C2)
2	UDN6118A	IC—Fluorescent Display Driver—Sprague (Z1, Z2)
1	6-JS-01	6-digit Display Tube—Futaba (DS1)

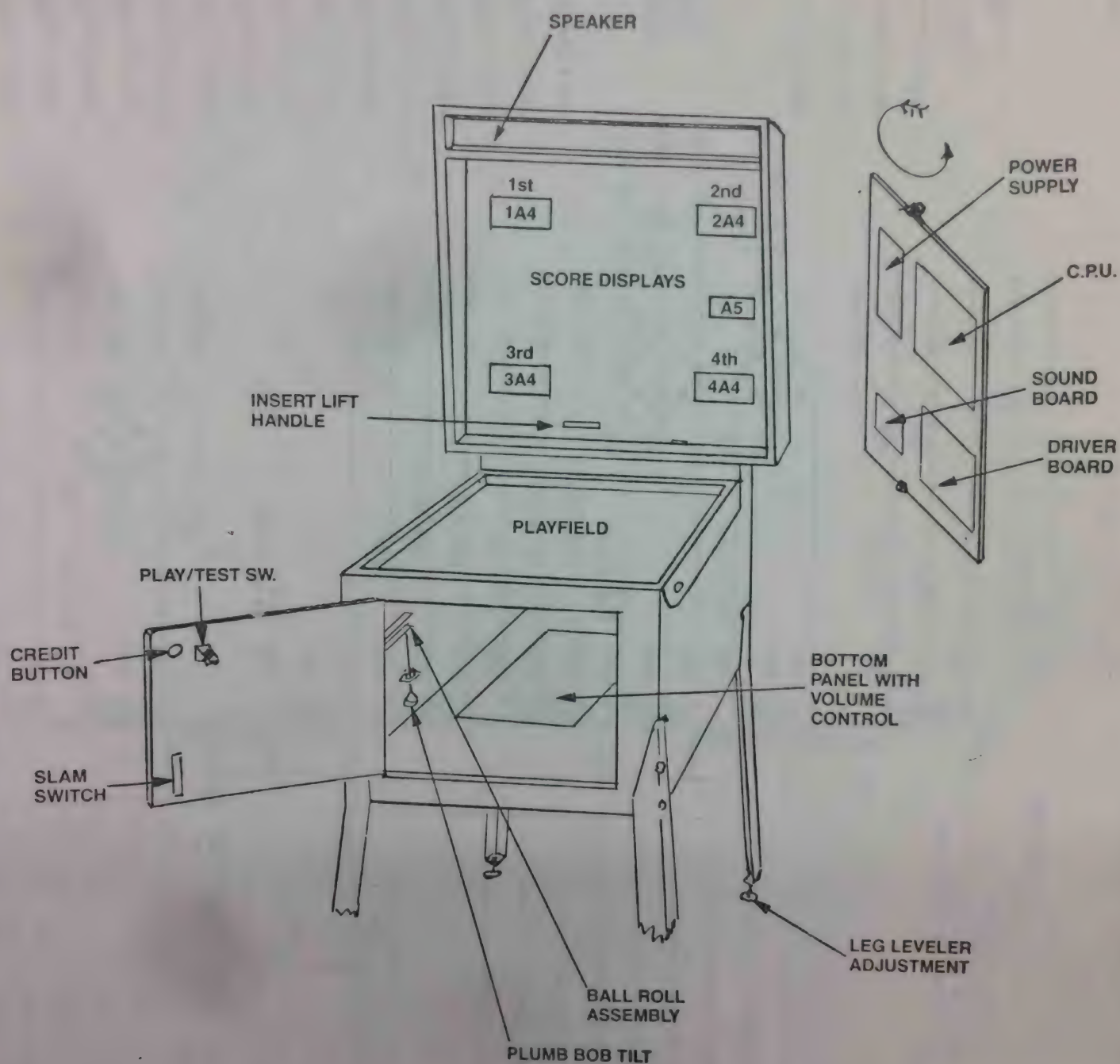
4-DIGIT DISPLAY

QUANTITY	NUMBER	DESCRIPTION
1	TE1400	Capacitor—1 Microfarad, 100V—Sprague (C-1)
2	C320C103MIR5CA	Capacitor—0.01 Microfarad, 100V—Kemet (C2, C3)
2	UDN6118A	IC—Fluorescent Display Driver—Sprague (Z2, Z3)
1	SN7432N	IC—Quad OR Gate—T.I. (Z1)
1	4-LT-11	4-digit Display Tube—Futaba (DS1)
2	721R01-113	Resistor—4.7K Ω , 1/4W, 5% (R1, R2)

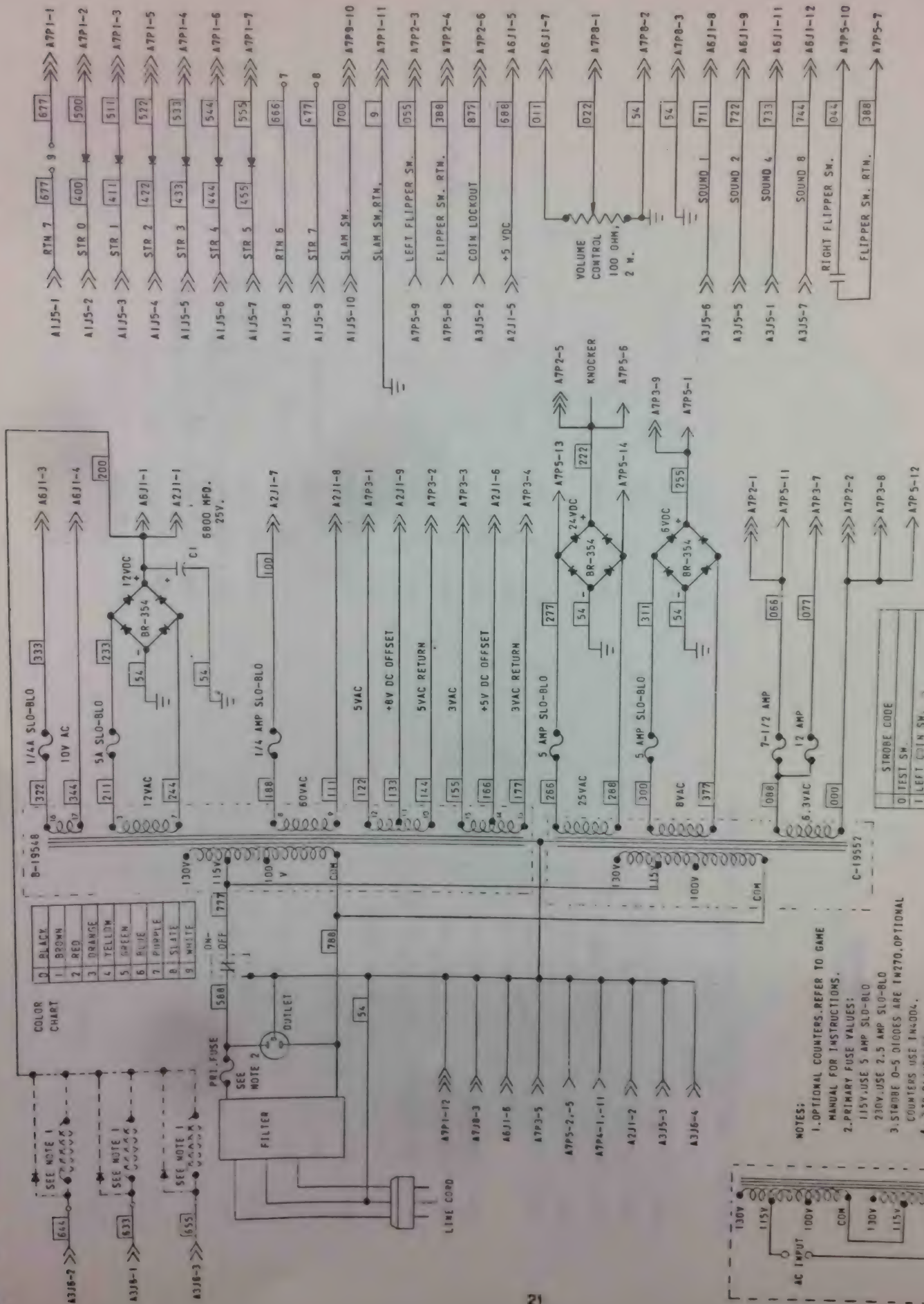
X. WIRING AND SCHEMATIC DIAGRAMS

- A. COMPONENT LOCATION DIAGRAM
- B. BOTTOM BOARD SCHEMATIC
- C. BOTTOM BOARD AND LIGHTBOX SCHEMATIC
- D. SWITCH MATRIX ASSIGNMENT DIAGRAM
- E. PLAYBOARD SOLENOID SCHEMATIC DIAGRAM
- F. PLAYBOARD ILLUMINATION SCHEMATIC DIAGRAM
- G. LIGHTBOX CABLE SCHEMATIC DIAGRAM
- H. CONTROL BOARD COMPONENT LOCATION DIAGRAM
- I. CONTROL BOARD SCHEMATIC DIAGRAM 1 OF 2
- J. CONTROL BOARD SCHEMATIC DIAGRAM 2 OF 2
- K. DRIVER BOARD COMPONENT LOCATION DIAGRAM
- L. DRIVER BOARD SCHEMATIC DIAGRAM
- M. 6 DIGIT DISPLAY SCHEMATIC AND COMPONENT LOCATION DIAGRAM
- N. 4 DIGIT DISPLAY SCHEMATIC AND COMPONENT LOCATION DIAGRAM
- O. POWER SUPPLY SCHEMATIC DIAGRAM
- P. SOUND BOARD SCHEMATIC DIAGRAM
- Q. SOUND BOARD COMPONENT LOCATION DIAGRAM
- R. POP BUMPER DRIVER BOARD SCHEMATIC DIAGRAM

X. A. COMPONENT LOCATION DIAGRAM

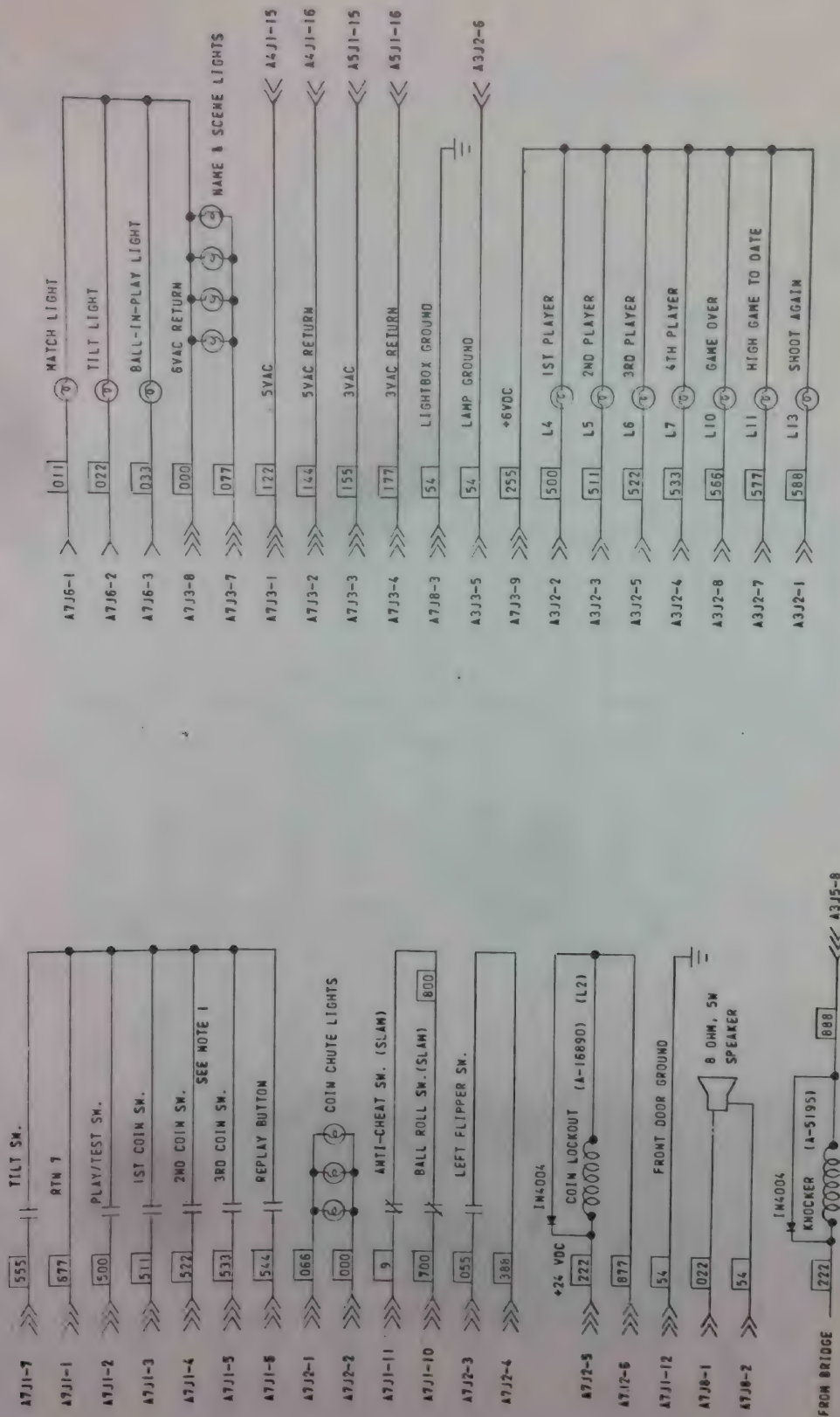


X. B. BOTTOM BOARD PANEL SCHEMATIC



D. GOTTLIEB & CO.	
TITLE BOTTOM PANEL SCHEMATIC	
USED ON	DATE
DRAWN	APPROVED
C-19686	

X. C. BOTTOM BOARD & LIGHTBOX SCHEMATIC

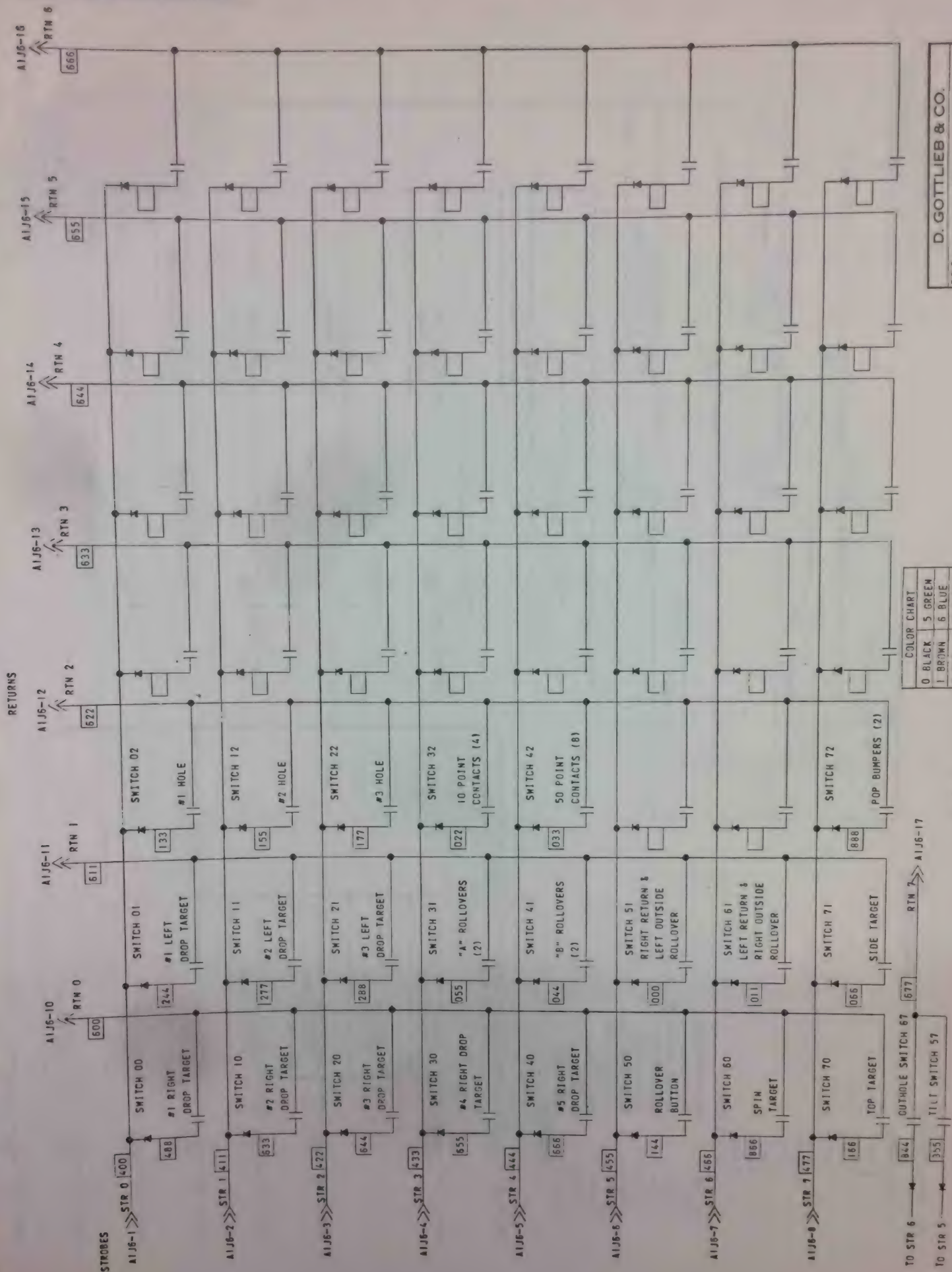


NOTE 1: REFER TO INSTRUCTION MANUAL FOR
GAMMA GAME VARIATIONS.

- > FROM PLAYBOARD
- >> FROM LIGHTBOX
- >>> FROM BOTTOM BOARD

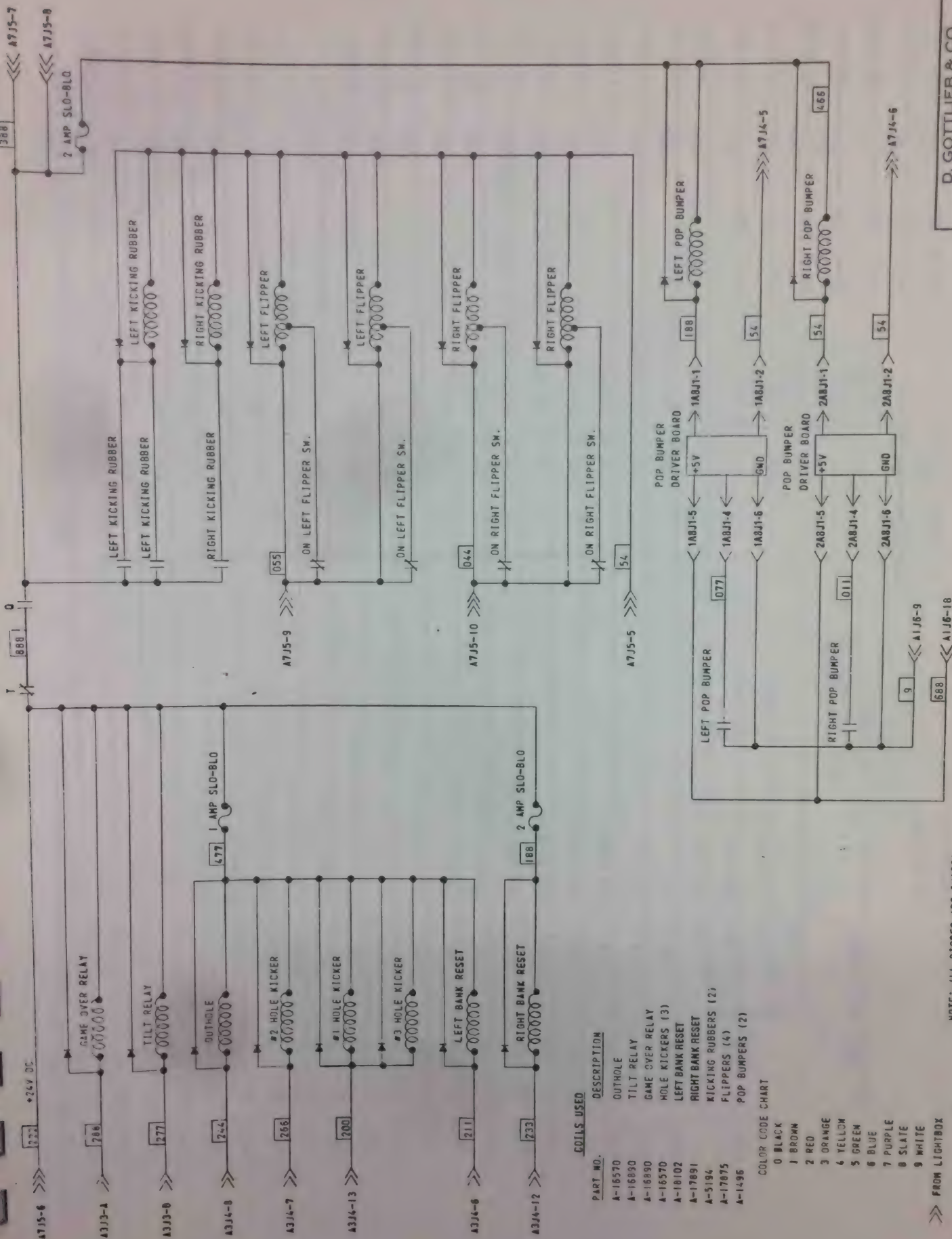
TITLE	D. GOTTLIEB & CO.
USED ON	BOTTOM BOARD & LIGHTBOX
SCHEMATIC	
UNSW	APPROVED DATE
	C-19690

X. D. SWITCH MATRIX



D. GOTTlieb & CO.
TYPE SWITCH MATRIX
USED ON
DRAWN APPROVED DATE
C-19823

E. PLAYBOARD SOLENOIDS



COILS USED

PART NO.	DESCRIPTION
A-16570	OUTHOLE
A-16890	TILT RELAY
A-16890	GAME OVER RELAY
A-16570	HOLE KICKERS (3)
A-18102	LEFT BANK RESET
A-17891	RIGHT BANK RESET
A-5194	KICKING RUBBERS (2)
A-17875	FLIPPERS (4)
A-1495	POP BUMPERS (2)

COLOR CODE CHART

0	BLACK
1	BROWN
2	RED
3	ORANGE
4	YELLOW
5	GREEN
6	BLUE
7	PURPLE
8	SLATE
9	WHITE

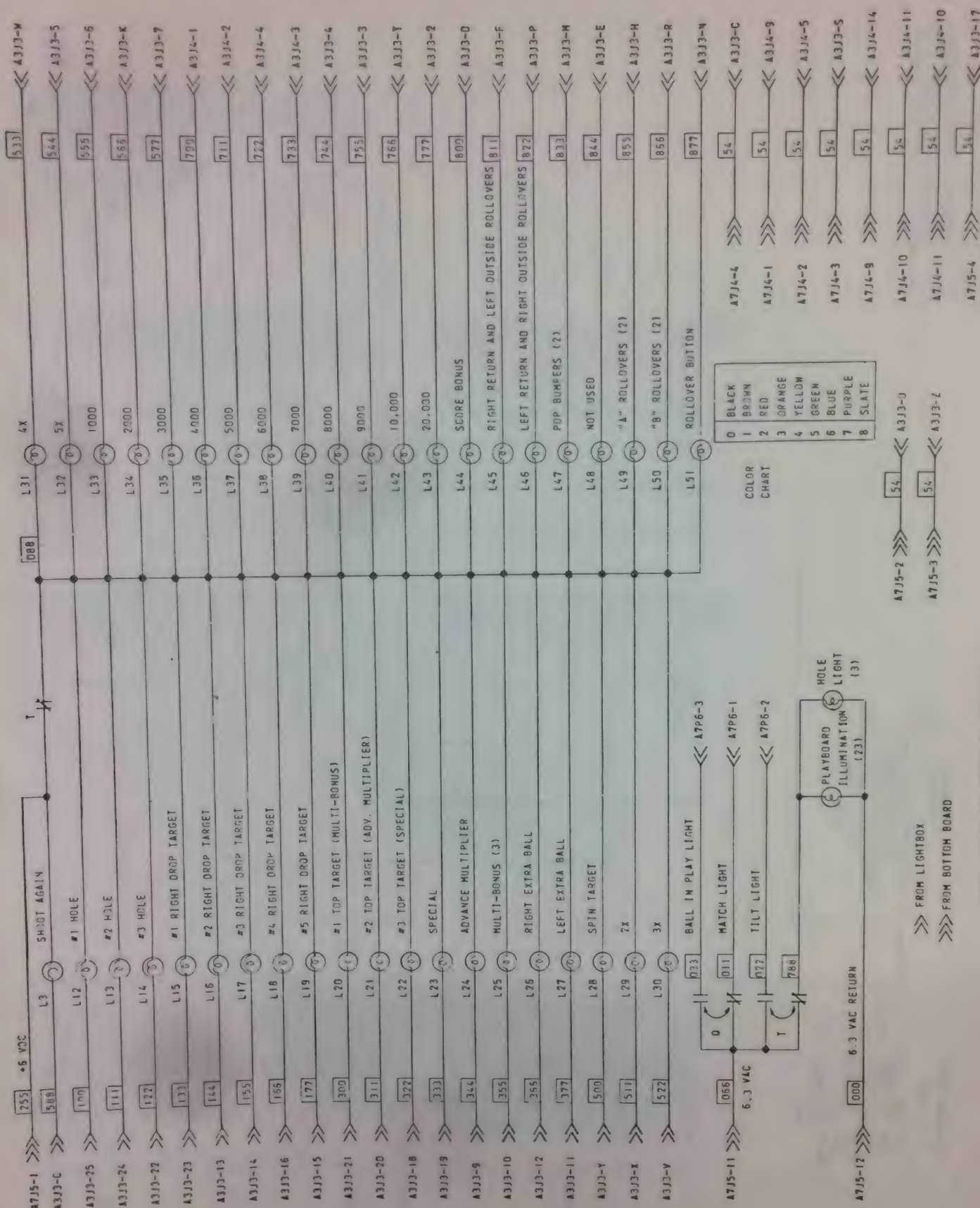
>>> FROM LIGHTBOX

>>> FROM BOTTOM BOARD

NOTE: ALL DIODES ARE 1N4004

D. GOTTLIEB & CO.	
TITLE PLAYBOARD SOLENOIDS	
USED ON	DATE
DRAWN	C-19824

X. F. PLAYBOARD ILLUMINATION

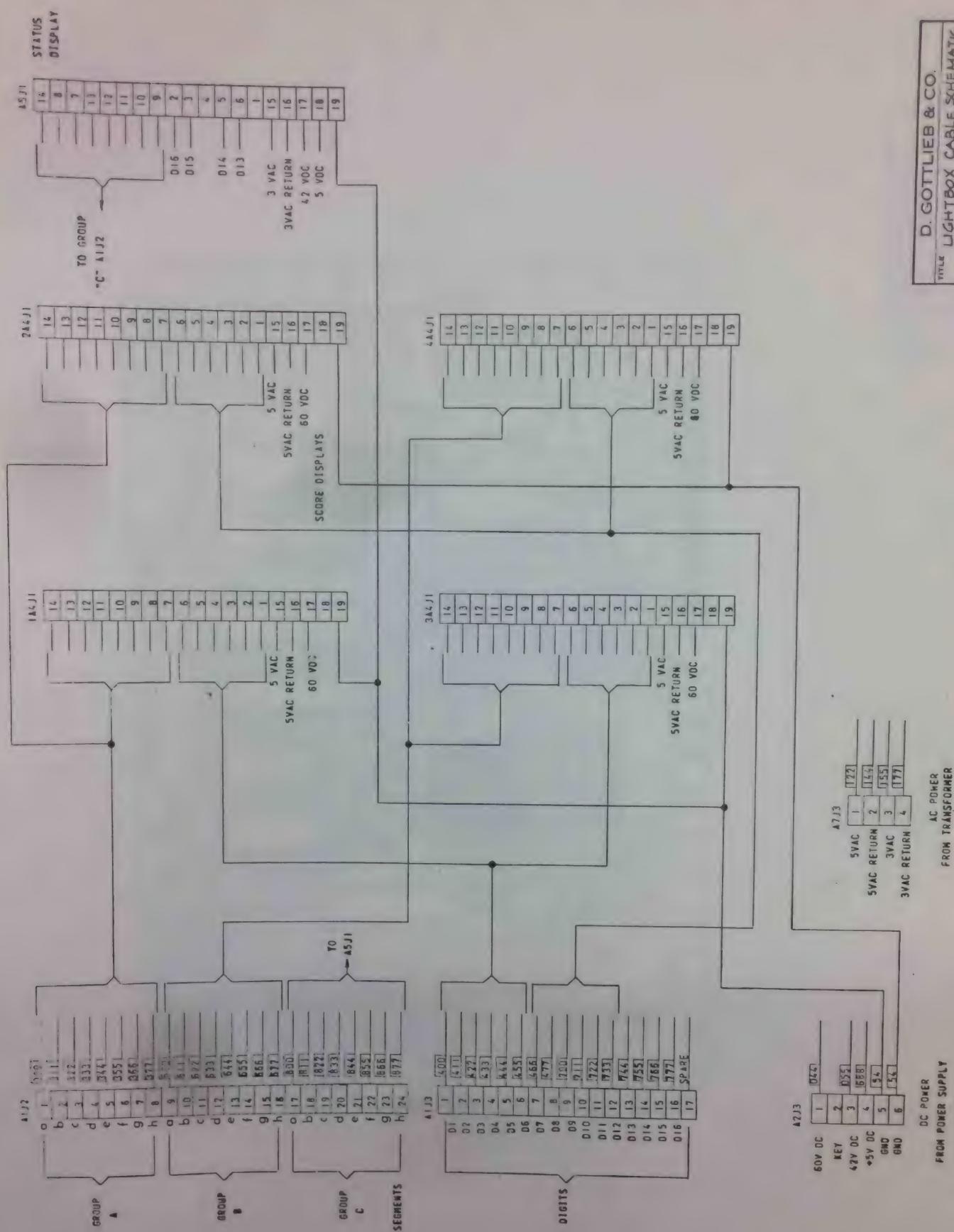


FROM LIGHTBOX

>>> FROM BOTTOM BOARD

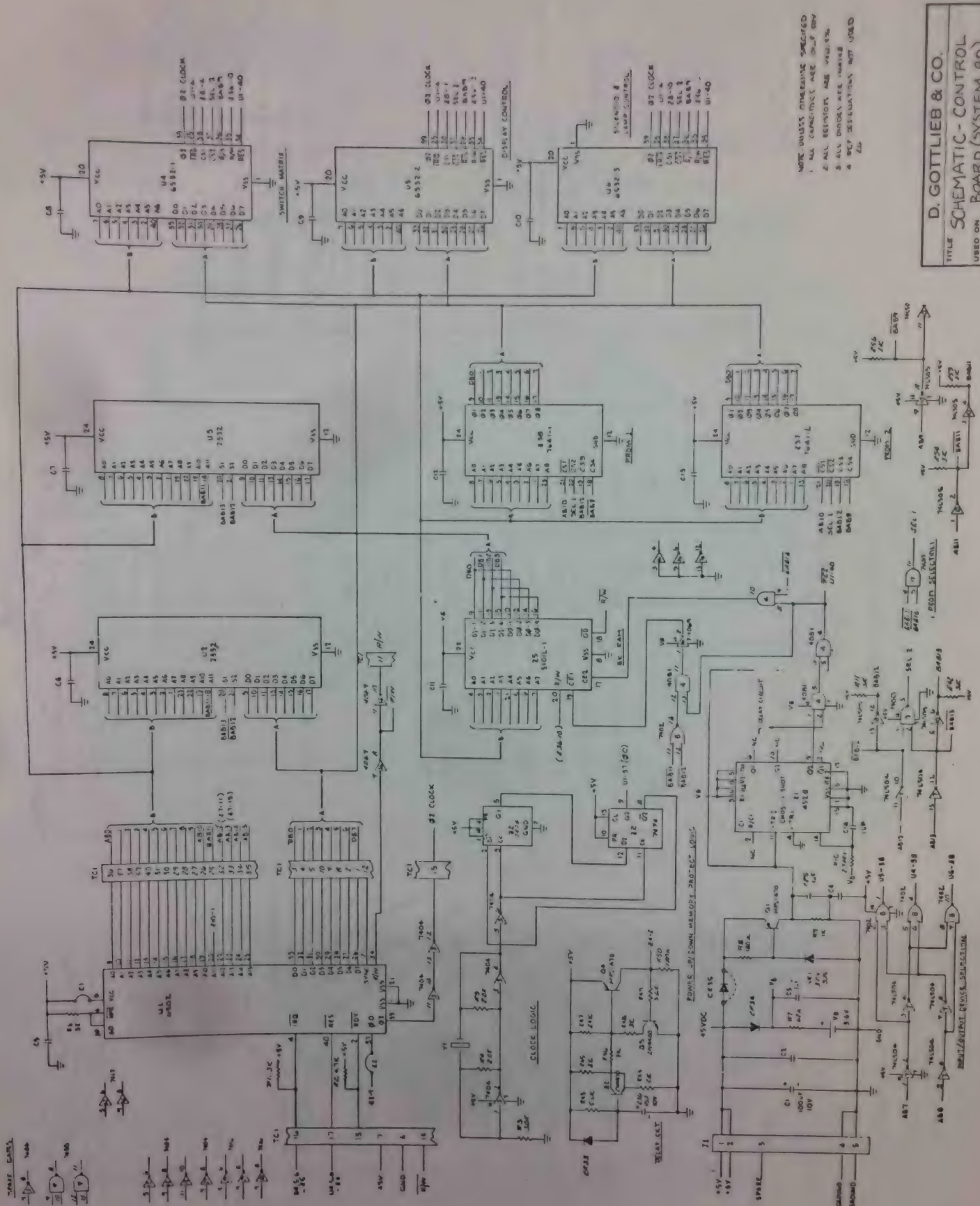
LAMPS L32-L43 ARE DRIVEN BY WPS A13'S.
ALL OTHER LAMP DRIVERS ARE WPS 1145'S.

G. LIGHTBOX CABLE SCHEMATIC



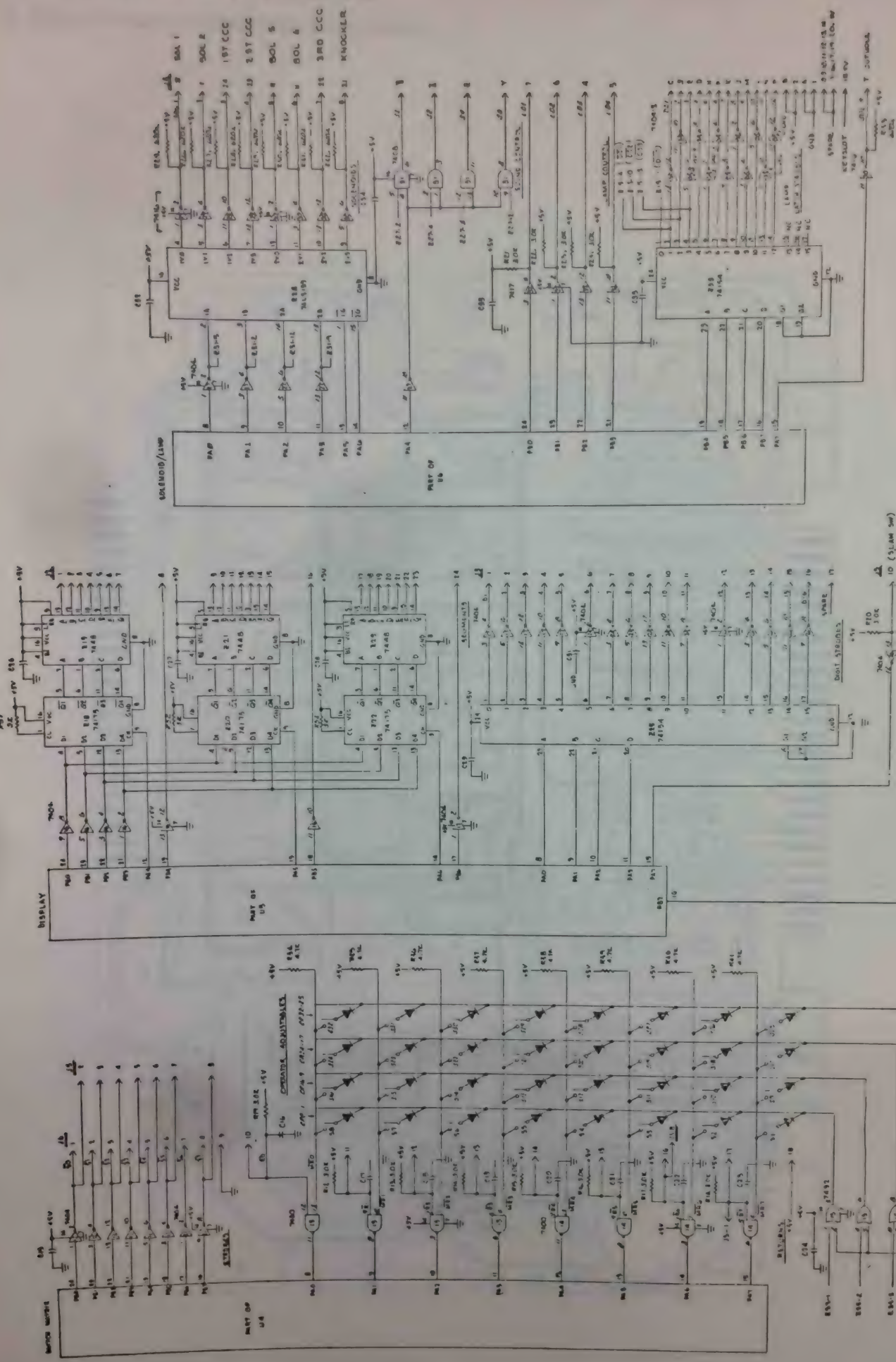
D. GOTTLIEB & CO.	
TITLE LIGHTBOX CABLE SCHEMATIC	
USED ON	APPROVED DATE
DRAWN	C-19692

I. CONTROL BOARD SCHEMATIC



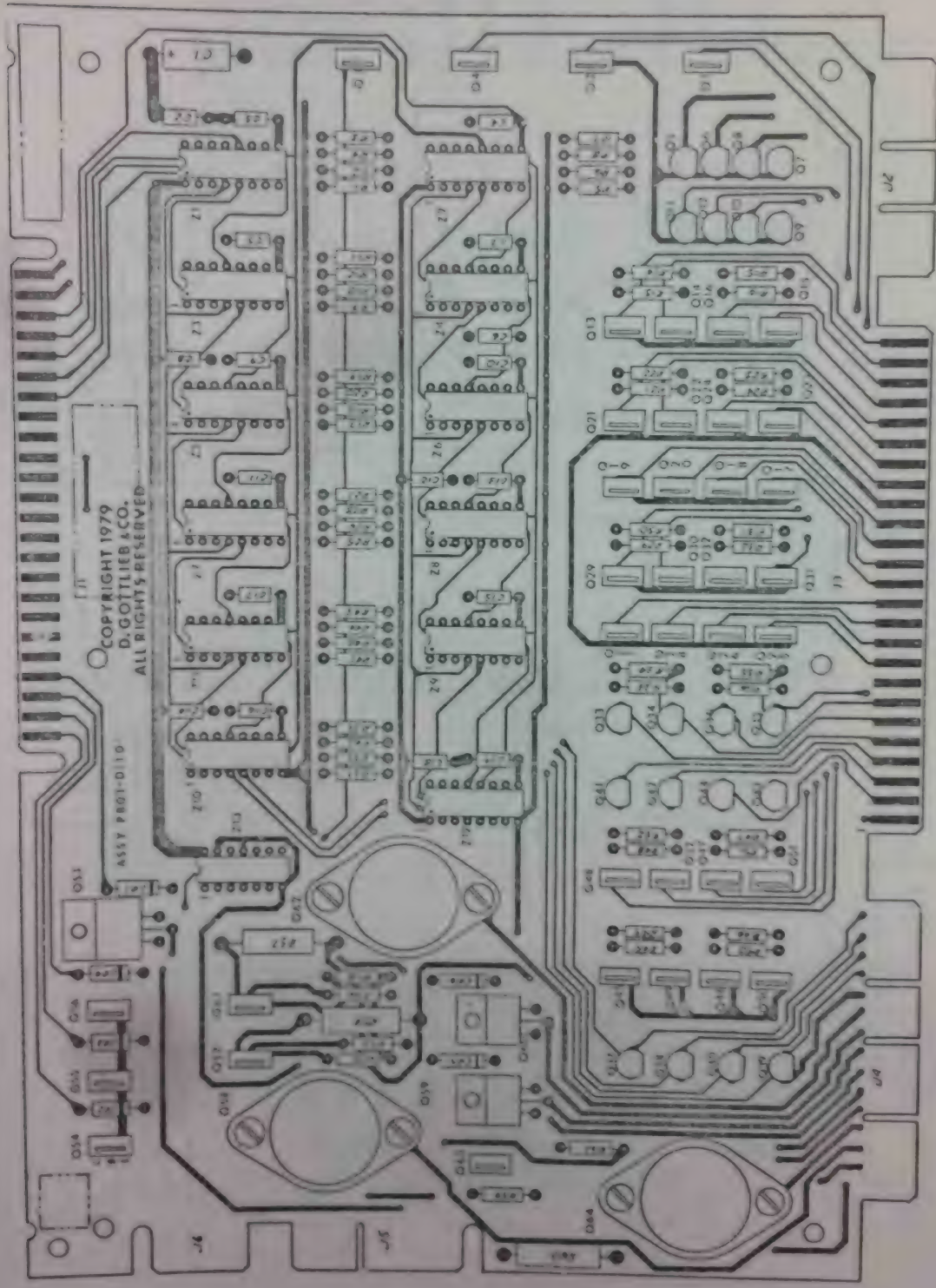
D. GOTTlieb & CO.	
SCHEMATIC - CONTROL	
USED ON BOARD (SYSTEM 80)	
DRAWN	APPROVED DATE
PB03-X101	

X. J. CONTROL BOARD SCHEMATIC



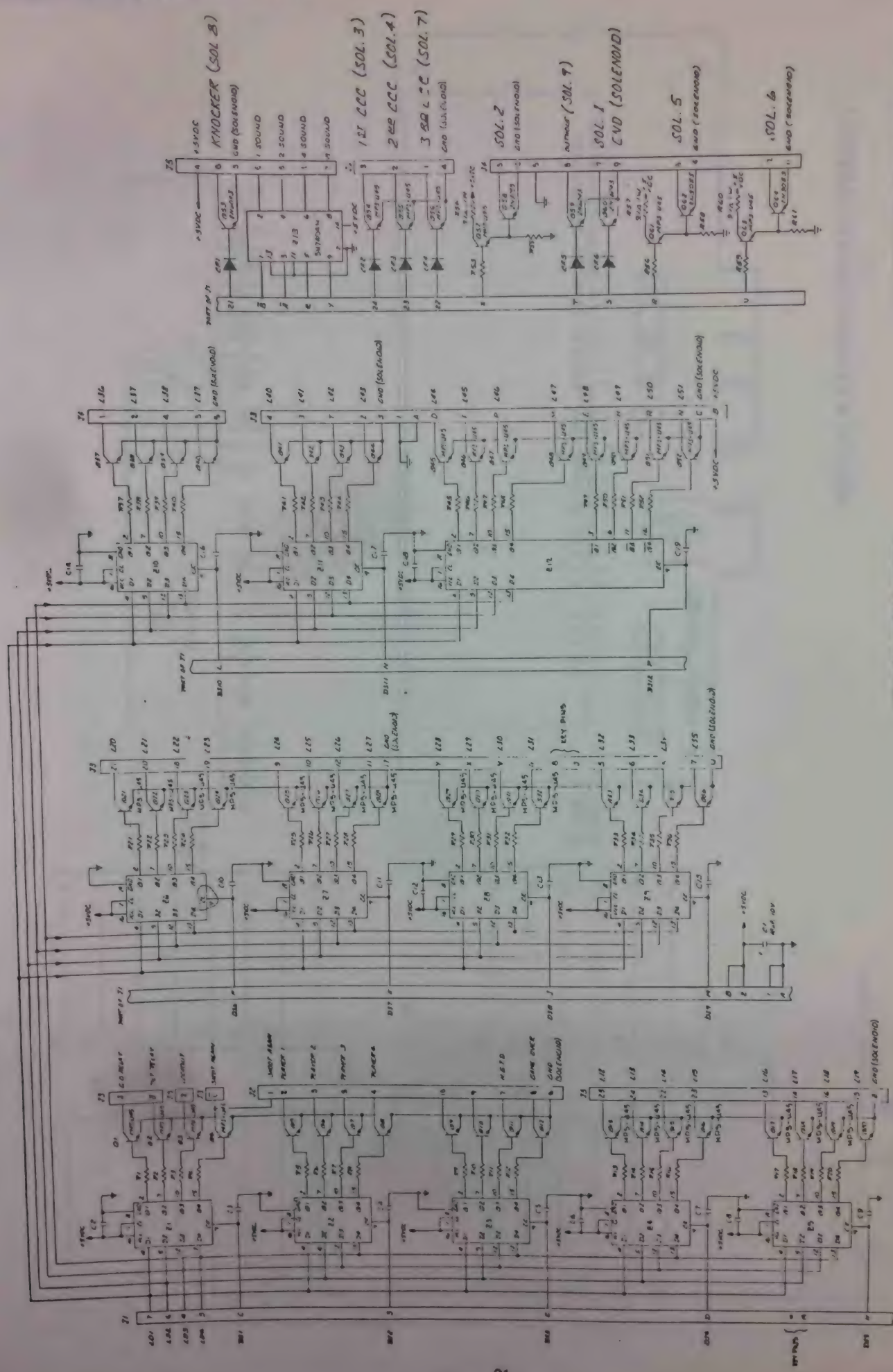
D. GOTTLIEB & CO.
 TITLE SCHEMATIC CONTROL
 USED ON BOARD - SYSTEM 80
 DRAWN APPROVED DATE PB03-X101
 SHEET 2 OF 2

K. DRIVER BOARD COMPONENT LOCATION



D. GOTTLIEB & CO.		
TITLE MASTER DRIVER		
USED SYSTEM 80		
DRAWN	APPROVED	DATE
PB03-D110		

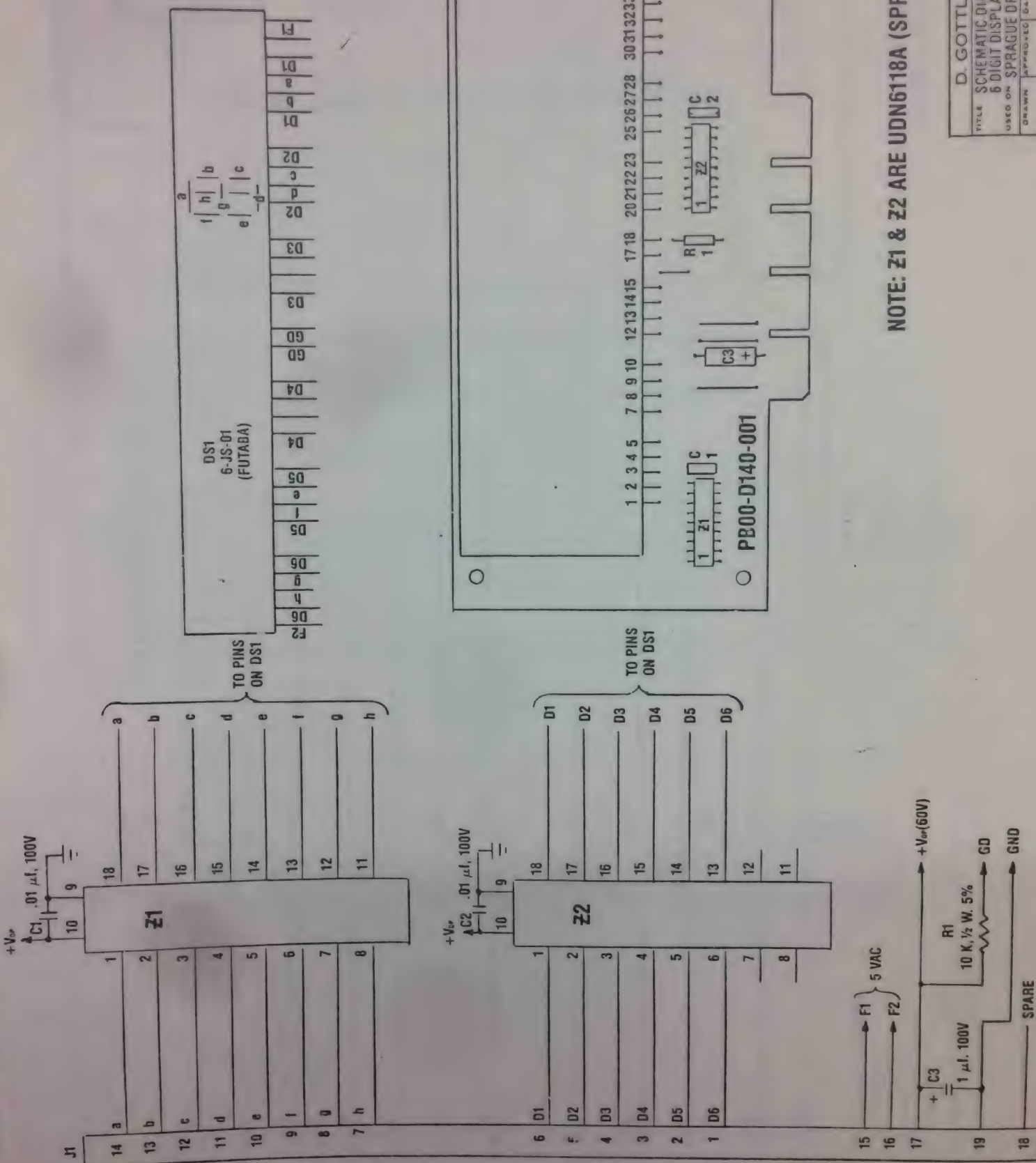
X. L. DRIVER BOARD SCHEMATIC



NOTE: UNLESS OTHERWISE SPECIFIED
1. REF. ASSEMBLY DWG. NO. PB03-0110
2. RESISTORS ARE 1% TOL. 5% 1/4W
3. TRANSISTORS ARE MFG. BY SONY, THRU Q2 AND Q35 THROUGH Q44
4. CAPACITORS ARE 50V 1/4W 10% TOL.
5. INTEGRATED CIRCUITS ARE SAMSUNG
6. DIMENSIONS ARE IN INCHES
7. SYMBOLS ARE AS SHOWN

D. GOTTlieb & CO.
SCHEMATIC DIAGRAM -
USED ON MASTER DRIVER SYSTEM 00
DRAWN APPROVED DATE
PB03-X111

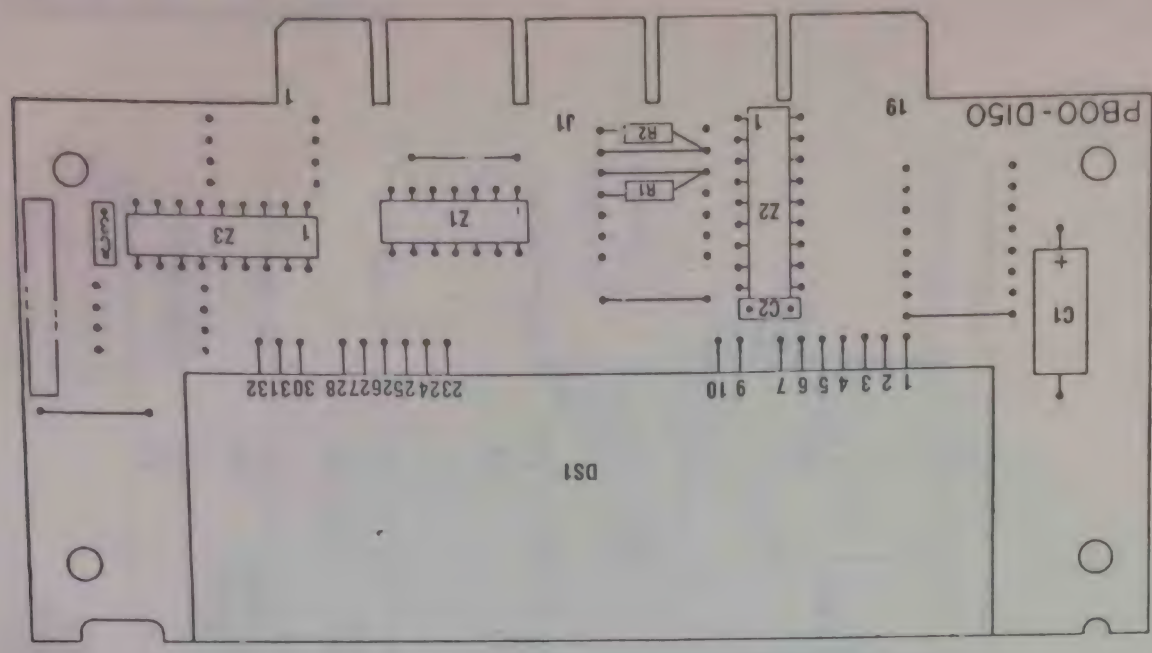
M. 6 DIGIT DISPLAY



NOTE: Z1 & Z2 ARE UDN6118A (SPRAGUE)

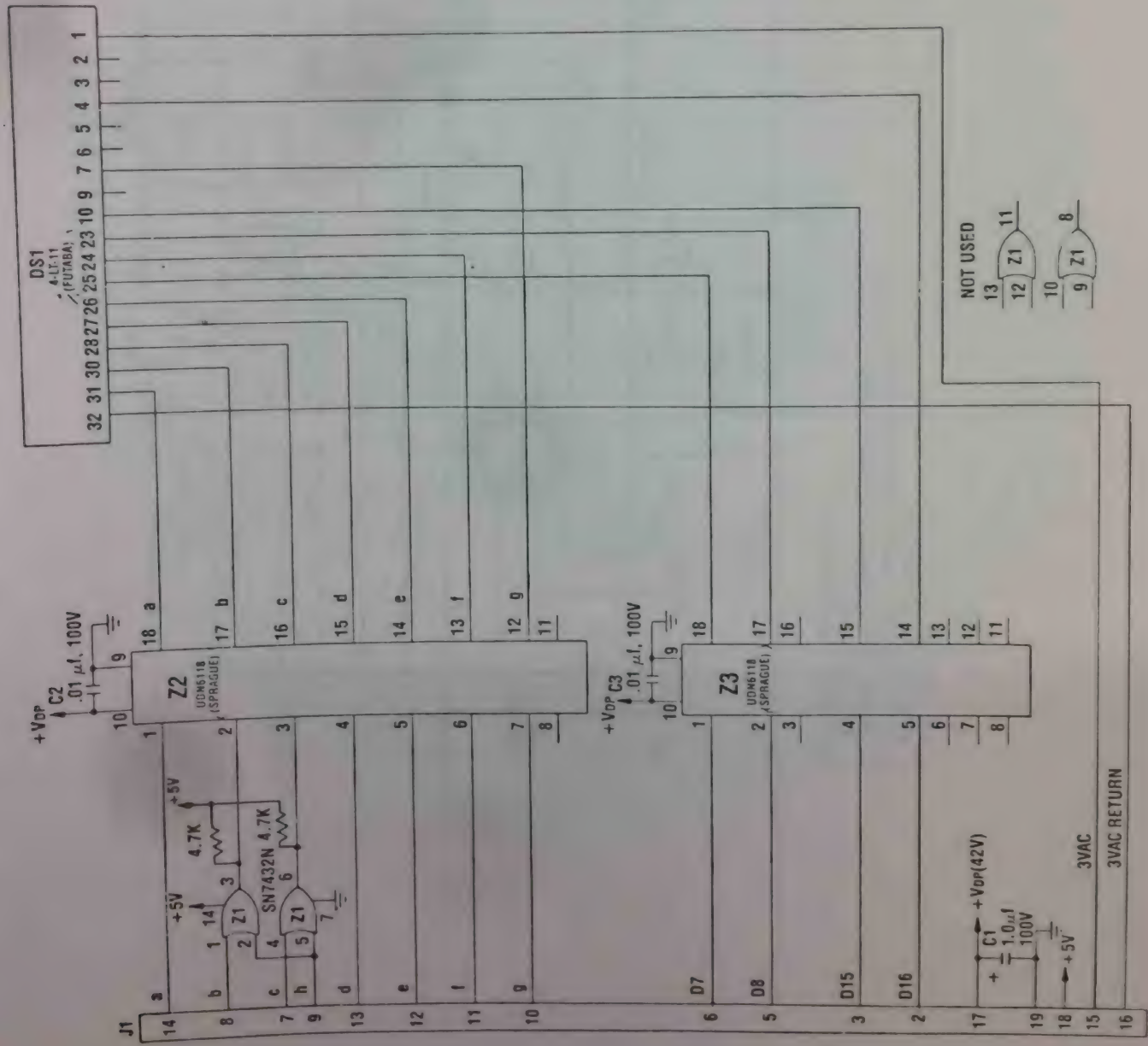
D. GOTTlieb & CO.	
TITLE	SCHEMATIC DIAGRAM — 6 DIGIT DISPLAY
USED ON	SPRAGUE DRIVER
DRAWN	APPROVED DATE
	P800-D140

X. N. 4 DIGIT DISPLAY

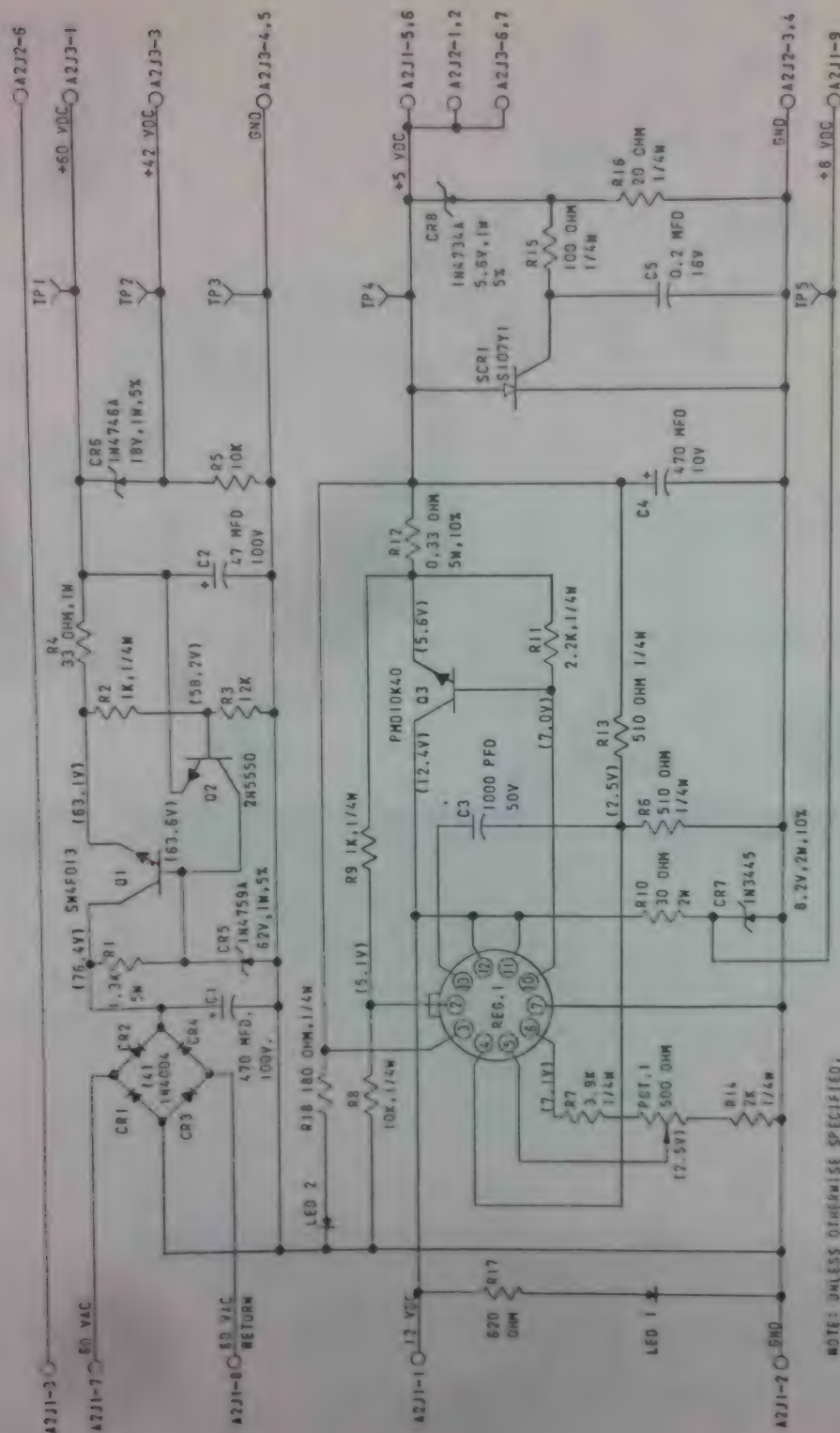


NOTE: RESISTOR VALUES ARE IN OHMS $\pm 5\%$ $\frac{1}{4}W$

D. GOTTLIEB & CO			
TITLE SCHEMATIC DIAGRAM -			
4 DIGIT DISPLAY			
USED IN	DATE	APPROVED	DATE
			P800-D150



O. POWER SUPPLY SCHEMATIC

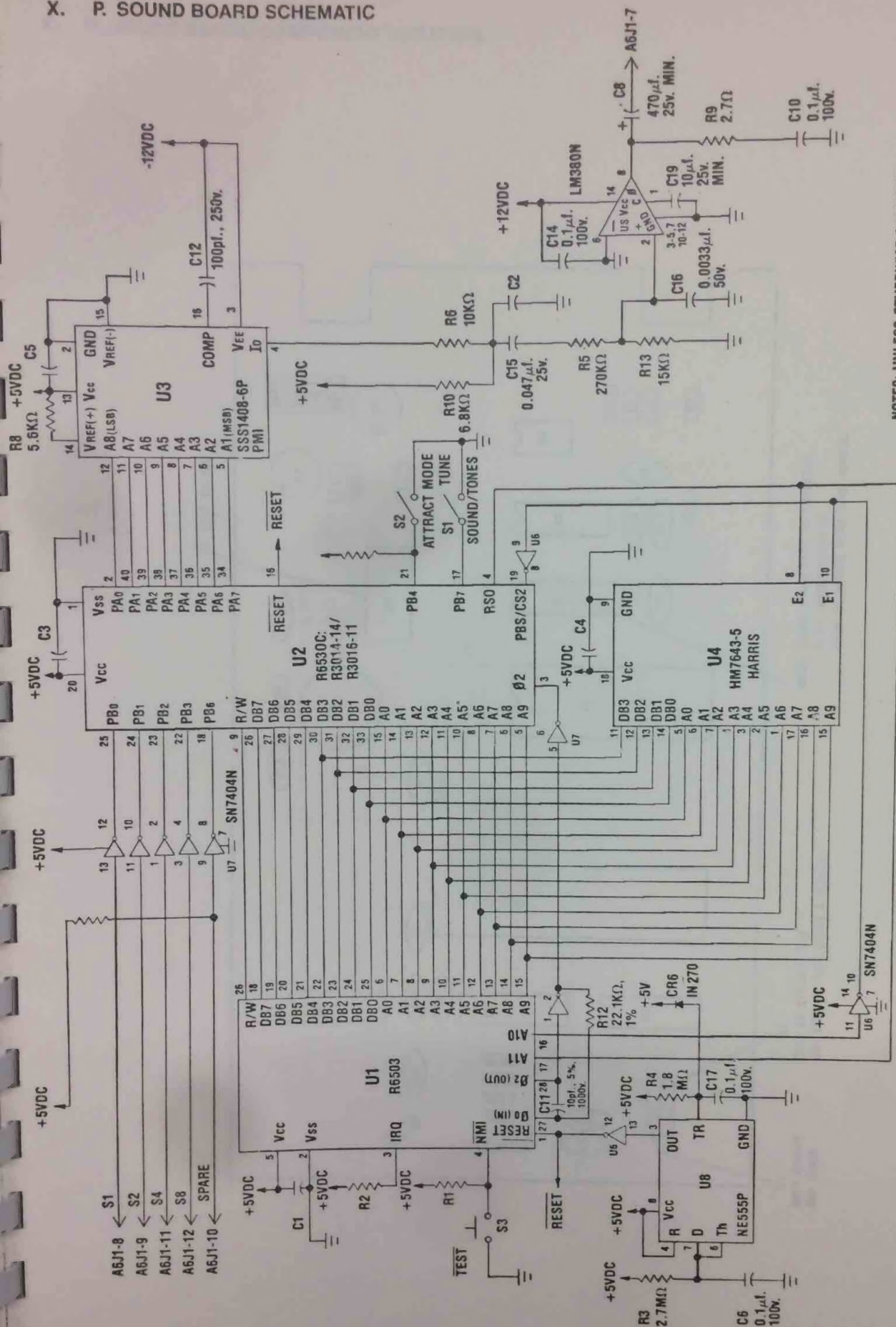


NOTE: UNLESS OTHERWISE SPECIFIED:

1. RESISTORS ARE 1/8W, 5%
2. VOLTAGES ARE DC WITH RESPECT TO CIRCUIT GROUND
3. ALL VOLTAGES ARE AT NOMINAL LINE VOLTAGE (115VAC)
4. REG.1 IS TYPE 723 16 PIN DIP
5. LEDs ARE RL6850

D. GOTTLIEB & CO.			
POWER SUPPLY SCHEMATIC			
USED ON SYSTEM 80			
DRAWN	APPROVED	DATE	B-19694

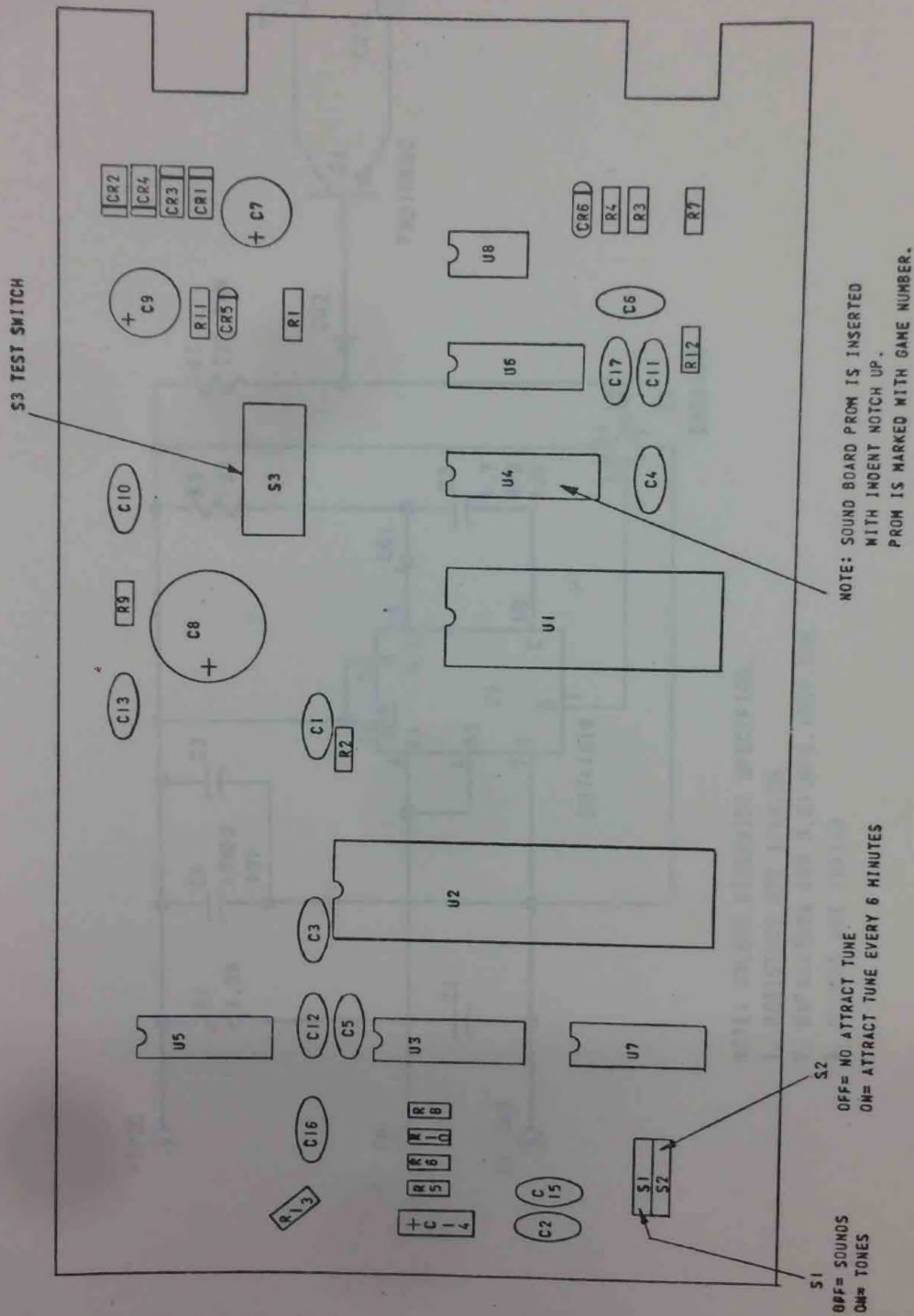
X. P. SOUND BOARD SCHEMATIC



NOTES: UNLESS OTHERWISE SPECIFIED:
 1. ALL RESISTORS ARE 2.7KΩ, ± 5%, 1/4W.
 2. ALL CAPACITORS ARE 0.01μf., 20%, 100V.
 3. ALL DIODES ARE 1N4004

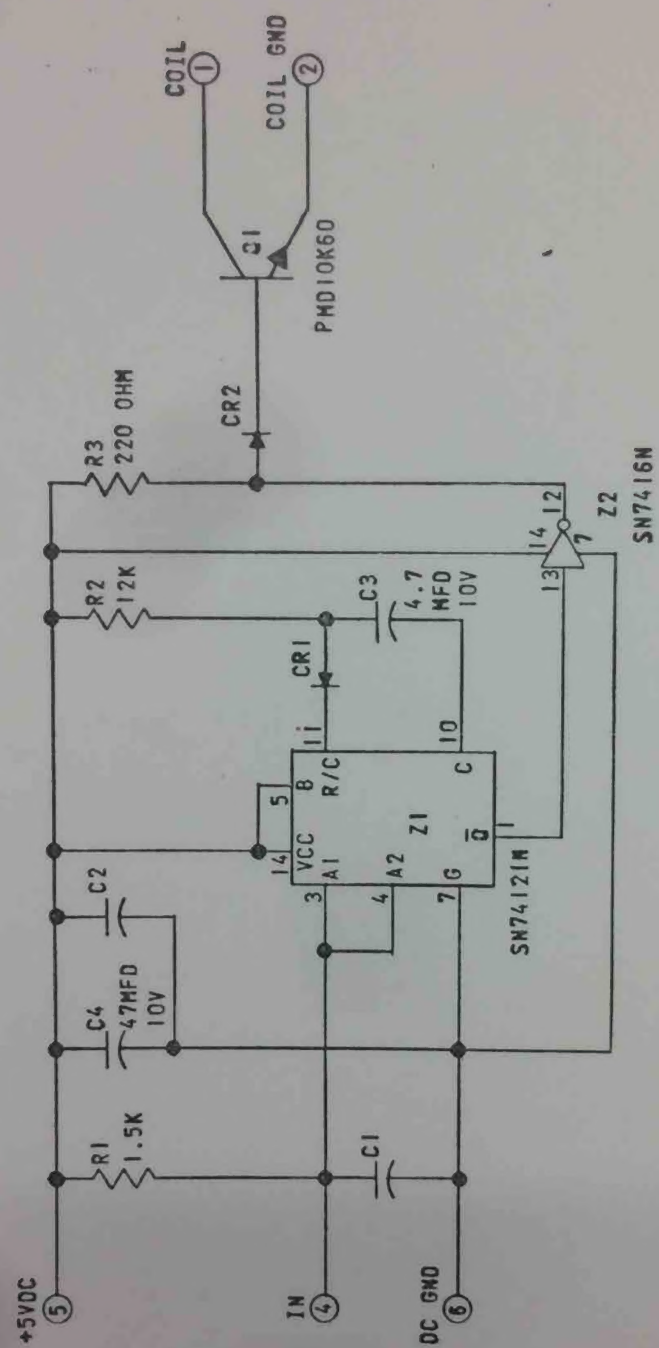
D. GOTTLIEB & CO.	
TITLE	SOUND BOARD
USED ON	SCHEMATIC
DRAWN	APPROVED DATE
ISSUE DATE	REVISIONS
	C-19691

K. Q. SOUND BOARD COMPONENT LOCATION



D. GOTTLIEB & CO.			
TITLE SOUND BOARD COMPONENT LOCATION			
USED ON SYSTEM 80			
DRAWN	APPROVED	DATE	B-

X. R. POP BUMPER DRIVER BOARD SCHEMATIC



NOTE: UNLESS OTHERWISE SPECIFIED.
1. RESISTORS ARE 1/4W, 5%
2. CAPACITORS ARE 0.01, MFD, 100V, 20%
3. DIODES ARE 1N4148

D. GOTTLIEB & CO.			
TITLE	POP BUMPER DRIVER BOARD		
USED ON	SYSTEM 80		
DRAWN	APPROVED	DATE	A-19602

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